# ECONOMIC ANALYSIS OF FARM-FIRM MANAGEMENT RISK IN NORTH FLORIDA

BY

KWABENA ASOMANIN ANAMAN

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1985

This study is dedicated to my parents,
Mr. A. G. Anaman and Madam Abena Ohenewaa
of Agona-Nsaba, Ghana, Africa, for their
sacrifices towards my personal development
including my education.

# ACKNOWLEDGEMENTS

I wish to thank first of all the Department of Food and Resource Economics, University of Florida, Gainesville, Florida, for financing the study covering the period August 1983 to August 1985.

My sincere thanks also go to all the members of my supervisory committee especially my chairman, Dr. W. G. Boggess, and Dr. Jim Jones of the Department of Agricultural Engineering for the valuable assistance in completing the study. Drs. John Holt, Ken Portier and Ron Ward; Messrs Tim Hewitt and Rom Aldermann, all of the Institute of Food and Agricultural Sciences, University of Florida, and several Extension Division officers of Jackson County, North Florida, helped with the design, data collection and analysis of the risk survey. I extend my appreciation to them.

Special thanks are reserved also for the entire Department of Food and Resource Economics especially the professors who taught me or guided my program, notably Drs. W. W. McPherson, C. F. Kiker, G. D. Lynne, Max Langham, Thomas Spreen, Fred Prochaska, Emilio Pagoulatos, Dan Tilley, Robert Emerson, Dave Mulkey and C. G. Davis for giving me the congenial atmosphere to undertake my graduate studies successfully and more importantly for helping me to develop my talents to much higher levels of creativity.

The income simulation model for the typical farm in North Florida was developed by me with valuable help from computer programmers--

Mr. Bruce Klein and Ms. Minh Trang Thi Le. The stochastic dominance analysis program used to evaluate different income probability distributions was written by Dr. Jack Meyer of Michigan State University in 1977 and modified slightly by Dr. Randy Kramer of Virginia Polytechnic and State University in 1980. Some modifications were made by me with the help of Mr. Bruce Klein in 1984 to allow the specific analyses of this study to be done more efficiently. I owe a debt of gratitude to all these people.

The drafts of this dissertation were typed by Misses Donna Fillmon and Tanya Streeter and Mrs. Dottie Scully. The final copy of the dissertation was typed by Mrs. Janet Eldred. I would like to express my thanks to all of them.

My stay in the United States for my graduate studies from 1979 to 1985 was made easier by several friends. They include Drs. S. Sarkodie-Kyeremeh, Pierre Abassa, Bicaba Banama, Peter Nkedi-Kizza, Evans Tetteh and family, Michael Adu-Tutu, Rick and Debra Linn, Mr. and Mrs. Willie Guinyard, Misses Tanya Streeter and Rosie Chikwana, Messrs Godwin Seshie, Philip J. d'Almada, Maybin Simfukwe and family, James Ansoannur and family, Harouna Kouassi, Victor Akatsa, Dweh Doeyan, Maynard Sawerengera, Daniel Maromo, Kafui Awuma, Kwasi Badu-Tweneboah and Alpha Keita Kabine. I would like to thank all of them for their help.

My teachers and professors at the University of Ghana, Legon, Ghana, from 1974 to 1977, especially Drs. J. A. Dadson and K. G. Erbynn, and my co-workers at the Center for Development Studies, University of Cape-Coast, Cape-Coast, Ghana, from 1977 to 1979 have all helped me a lot in numerous ways towards my education, and I owe them a debt of gratitude.

I extend my appreciation to the farmers of Ghana and those men and women who fought for the political independence and founded the modern state of Ghana, notably Dr. Kwame Nkrumah. They gave me the access to education which allowed me to reach these heights of intellectual attainment. My parents have contributed a great deal of resources and sacrifices toward my personal development including my education and the dissertation is dedicated to them.

Finally, bowing to African tradition, my gratitude goes to the Supreme Being for the guidance and help in my entire educational career. I pray for more help and guidance in my professional career.

# TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS ........................................ iii

LIST OF TABLES ........................................ x

LIST OF FIGURES ........................................ xiv

ABSTRACT ........................................ xv

CHAPTERS

1 INTRODUCTION ........................................ 1

The Problem Statement ........................................ 1
Objectives of the Study ........................................ 6
Organization of the Study ........................................ 7

2 LITERATURE REVIEW ........................................ 8

General Review of the Farm Risk Literature ........................................ 8
Review of Analytic Methods and Tools Used in the Study ........................................ 14

Utility Theory of Risk ........................................ 14
Logistic Regression ........................................ 18
Stochastic Dominance and Risk Efficiency ........................................ 20
Simulation Modeling ........................................ 29

3 METHODOLOGY ........................................ 34

Introduction ........................................ 34
Survey Sampling and Administration Procedures ........................................ 34

Procedures and Methods Involved in the Stochastic Stochastic Modeling Analysis of Risk-Management Scenarios for the Typical Farm in North Florida ........................................ 38

The Base Income Simulation Model ........................................ 40

Modeling the marketing strategies ........................................ 46
Cash sales of the crops at harvest time ........................................ 47
Forward contracting ........................................ 48

Page

Hedging .......................................... 48
Futures options .................................. 49

Sources of Data for the Income Simulation Model ..... 52
The Stochastic Dominance Analysis .................. 56
The Hypotheses Tested .............................. 57

4 RESULTS OF THE FARM SURVEY RISK ANALYSIS ................ 61

Farmers' Definitions of Risk ............................ 61
Information Needs for Dealing with Farm Risks ........... 61
Socioeconomic Characteristics of the Farmers ............ 63
Sources of Farm Risks ................................... 76
Management Responses to Risk ............................ 78
Relationship Between Socioeconomic Characteristics of Farmers and the Importance Attached to the Sources of Risk ........................................ 82
Relationship Between Socioeconomic Characteristics of Farmers and the Risk-Management Responses .......... 86

Equation 1: Maintaining Financial Reserves ......... 90
Equation 2: Holding Credit Reserves ................ 90
Equation 3: Debt Management ........................ 91
Equation 4: Utilizing Government Credit Programs ......................................... 91
Equation 5: Off-Farm Activities by the Farm Operator .......................................... 92
Equation 6: Off-Farm Activities by Other Members of the Family ............................ 92

5 RESULTS OF THE STOCHASTIC MODELING ANALYSIS OF THE VARIOUS RISK-MANAGEMENT SCENARIOS FOR THE TYPICAL FARM ...................................................... 94

Evaluation of the Income Simulation Model ............... 94
Results from the Analysis of the Base Model of the Typical Farm ........................................... 99

Sample Size and Risk-Efficiency Rankings of Farm Plans ......................................... 99
Other Results Derived from the Base Model Analysis ......................................... 104
Evaluation of the Marketing Strategies ............. 112

Sensitivity Analysis Involving Changes in the Parameters in the Base Model .......................... 122

Variation in the 1984 Total Costs of Irrigation ..... 123
Changes in the Peanuts Acreage or Allotment in the Base Model and Replacement with Other Crops ............................................. 128

Page

Variation in the Amounts of Corn and Soybeans Sold in the Future Market Either through Hedging or Futures Options ........................ 135
Variation in the Amounts of Crops Forward-Contracted ........................................ 142
Variation in the Premium and Strike Price under the Futures Options Marketing Strategy ...... 145

6 CONCLUSIONS AND RECOMMENDATIONS .......................... 157

Policy Implications of the Study ........................ 157
Limitations of the Study ................................ 158
Suggestions for Further Research ........................ 159

APPENDICES

A THE 1983 FARM RISK SURVEY QUESTIONNAIRE .................. 163

B STEPS INVOLVED IN BUILDING THE INCOME SIMULATION MODEL ................................................. 194

C SIMULATED YIELDS AND IRRIGATION WATER USE FOR CORN, PEANUTS, SOYBEANS AND WINTER WHEAT FOR 17 WEATHER OR "PRODUCTION" YEARS (1955-1971) USED AS DATA IN THE INCOME SIMULATION MODEL .................. 197

D CASH PRICES FOR CORN, PEANUTS, SOYBEANS AND WINTER WHEAT FROM 1970 TO 1984 USED AS DATA IN THE INCOME SIMULATION MODEL ........................................ 205

E FUTURES PRICES FROM 1970 TO 1984 FOR CORN AND SOYBEANS USED AS DATA FOR THE HEDGING AND FUTURES OPTIONS MARKETING STRATEGIES IN THE INCOME SIMULATION MODEL ........................................ 210

F ESTIMATED 1984 COSTS OF PRODUCTION OF CORN, PEANUTS, SOYBEANS AND WINTER WHEAT (EXCLUDING COSTS OF IRRIGATION) FOR NORTH FLORIDA USED FOR THE INCOME SIMULATION MODEL ............................ 214

G ITEMS USED TO ESTIMATE THE COSTS OF IRRIGATION FOR THE TYPICAL FARM IN NORTH FLORIDA FOR 1984 ........... 219

H THE INCOME SIMULATION MODEL COMPUTER PROGRAM IN FORTRAN ................................................ 221

I THE STOCHASTIC DOMINANCE WITH RESPECT TO A FUNCTION PROGRAM IN FORTRAN ............................ 230

Page

REFERENCES CITED .................................................. 237

OTHER CONSULTED WORKS .......................................... 244

BIOGRAPHICAL SKETCH ............................................. 248

# LIST OF TABLES

Table Page

2-1 Common Probability Distributions Used in Simulation Modeling .......... 31

3-1 Planting and Harvesting Dates for the Four Crops in North Florida .......... 39

3-2 Listing of the Risk-Management Scenarios Modeled in the Income Simulation Model (Base Model) .......... 41

3-3 Definition of Groups of Farmers According to the Lower and Upper Bound of Their Absolute Risk-Aversion Coefficient .......... 58

4-1 Educational Level of Sample Farmers .......... 64

4-2 Classification of Sample Farmers by Length of Experience in Farming .......... 66

4-3 Classification of Sample Farmers According to Size of Farm Presently under Crops and Harvestable Forage .......... 67

4-4 Classification of Sample Farmers According to Their 1982 Taxable Farm Income .......... 68

4-5 Classification of Sample Farmers According to the Leverage Ratio of Their Farms .......... 69

4-6 Socioeconomic Characteristics of the Sample Respondents by Size (Acreage) of Farms .......... 70

4-7 Socioeconomic Characteristics of the Sample Respondents by the Financial Leverage Ratio of Their Farms .......... 74

4-8 Mean Importance Rankings and Standard Deviations of Sources of Risk and Variability in Crop Production .......... 77

4-9 Mean Importance Rankings and Standard Deviations of Sources of Risk and Variability in Livestock Production .......... 79

Table Page

4-10 Mean Importance Rankings and Standard Deviations of Management Responses Towards Risk and Variability in Both Crop and Livestock Production ...... 80

4-11 Sources of Risk and Variability in Crop and Livestock Production That Are Significantly Positively Related to Socioeconomic Characteristics of Farmers ........................................... 84

4-12 Sources of Risk and Variability in Crop and Live-Stock Production That Are Significantly Negatively Related to Socioeconomic Characteristics of Farmers ........................................... 85

4-13 Results of Logit Regression of the Risk-Management Responses Versus the Socioeconomic Characteristics of Farmers ........................................ 88

5-1 Mean and Standard Deviations of Incomes of the Six Most Likely Used Risk-Management Scenarios Modeled in the Income Simulation Model ......................... 96

5-2 Actual 1982 Taxable Mean Incomes for the Different Categories of Farms in Dollars Derived from a Survey of Farmers in North Florida and South Alabama ........................................... 98

5-3 Efficient Set of Risk-Management Scenarios According to the Utility Groups of Farmers and the Sample Size or the Number of Replications Used to Estimate the Cumulative Probability Distribution of Income for the Typical Farm in North Florida under 1984 Conditions ................... 100

5-4 Means, Standard Deviations and the Coefficients of Variation of Incomes for the Various Risk-Management Scenarios for the Typical North Florida Farm (Base Model) in 1984 Dollars ..................... 105

5-5 Probabilities of the Model Typical Farm Achieving Less Than the Different Levels of Critical Income (Amount of Short-Term Debts Obligations) for the Different Risk-Management Scenarios for 1984 Conditions ........................................... 111

5-6 Risk-Efficient Comparisons of Three Marketing Alternatives Available to the Typical Farm in North Florida--Forward Contracting, Hedging and Futures Put Options under 1984 Conditions for the Different Utility Groups of Farmers .................. 114

Table Page

5-7 Mean Incomes and the Coefficient of Variation of Incomes for the Various Irrigated Risk-Management Scenarios with Variation in the Total Costs of Irrigation for the Typical North Florida Farm in 1984 Dollars ........................................ 124

5-8 Efficient Set of Risk-Management Scenarios for the Different Utility Groups of Farmers with Variation in the 1984 Total Irrigation Costs for the Typical Farm in North Florida ................. 126

5-9 Mean Income and the Coefficients of Variation of Income for the Various Risk-Management Scenarios with Substitution of Acreage Allotment of Peanuts by Either Corn, Soybeans or Wheat in 1984 Dollars ...... 130

5-10 Mean Income in Dollars and the Coefficient of Variation of Income for the Various Risk-Management Scenarios with Changes in the Degree of Usage of the Futures Markets for the Typical North Florida Farm under 1984 Conditions .............. 137

5-11 Efficient Set of Risk-Management Scenarios According to the Utility Groups of Farmers and the Level of Usage of Futures Market for the Typical Farm in North Florida under 1984 Conditions ............................................ 140

5-12 Mean Income in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in the Level Amounts of Four Crops Forward Contracted for the Typical Farm in North Florida under 1984 Conditions ............................................ 143

5-13 Efficient Set of Risk-Management Scenarios for the Different Utility Groups of Farmers with Variation in the Level or Amounts of the Four Crops Forward Contracted for the Typical Farm in North Florida under 1984 Conditions ................... 144

5-14 Mean Incomes in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in Premium and Strike Prices for the Futures Put Options for Corn under 1984 Conditions ....................... 147

Table Page

5-15 Mean Incomes in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in Premium and Strike Prices for the Marketing Options for Soybeans under 1984 Conditions ........................ 149

C-1 Corn Yields in Bushels per Acre ........................ 197

C-2 Peanuts Yields in Pounds per Acre ...................... 198

C-3 Soybeans Yields in Bushels per Acre .................... 199

C-4 Winter Wheat Yields in Bushels per Acre ................ 200

C-5 Corn Irrigation Water Use in Acre-Inches ............... 201

C-6 Peanuts Irrigation Water Use in Acre-Inches ............ 202

C-7 Soybeans Irrigation Water Use in Acre-Inches ........... 203

D-1 Cash Prices for Corn per Bushel in Dollars ............. 205

D-2 Cash Prices for Soybeans per Bushel in Dollars ......... 207

D-3 Cash Prices for Winter Wheat per Bushel in Dollars ..... 208

E-1 Basis Data for Corn and Soybeans in Dollars per Bushel for North Florida .............................. 210

E-2 Corn Futures Prices in Dollars per Bushel .............. 211

E-3 Soybeans Futures Prices in Dollars per Bushel .......... 212

F-1 Estimated Costs of Producing One Acre of Dryland Corn, North Florida, 1984 ............................ 214

F-2 Estimated Costs of Producing One Acre of Peanuts, North Florida, 1984 .................................. 215

F-3 Estimated Costs of Producing One Acre of Soybeans, North Florida, 1984 .................................. 216

F-4 Estimated Costs of Producing One Acre of Winter Wheat, North Florida, 1984 ............................ 217

# LIST OF FIGURES

| Figure | | Page |
|---|---|---|
| 1-1 | Map of Florida Showing North Florida Counties Including Jackson County, the Area of the Study ........ | 5 |
| 2-1 | Diagrammatic Representation of Risk Aversion and the Cost of Risk ....................................... | 16 |
| 3-1 | Flow Chart of Steps Involved in Determining the Risk-Efficient Set of Farm Plans ...................... | 59 |
| 5-1 | Variation in the Basis for August (Harvest Time) Corn in North Florida ................................ | 117 |
| 5-2 | Variation in the Basis for November (Harvest Time) Soybeans in North Florida ............................. | 118 |
| 5-3 | Change in Futures Prices (CIFP) for Corn from Planting Time (March) to the Time of Delivery of the Futures Options (August) ....................... | 120 |
| 5-4 | Change in Futures Prices (CIFP) for Soybeans from Planting Date (May) to the Time of the Delivery of the Futures Options (October) ...................... | 121 |

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

# ECONOMIC ANALYSIS OF FARM-FIRM MANAGEMENT RISK IN NORTH FLORIDA

By

Kwabena Asomanin Anaman

August 1985

Chairman: Dr. William G. Boggess
Major Department: Food and Resource Economics

The first part of the study is devoted to the procedures used and the results of a survey of sample farmers in North Florida and South Alabama to determine their perceptions of the importance of various sources of risk and management responses towards risk. Initially, farmers are asked to define risk and then to rank various sources of risk and management responses based on the relative importance of each in their farming operations. Summary statistics, chi-square analysis and logistic regression techniques are used to analyze the farm survey results.

The results indicate that rainfall variability, variability in commodity prices, and diseases and pests are the major sources of risk in crop and livestock production. The size of the farm, experience in farming of the operator, the leverage ratio of the farm and the production of peanuts as the dominant crop are the four major socioeconomic characteristics that influence the use of certain risk-management practices.

The second part of the study deals with the stochastic modeling analysis of the various risk-management scenarios for the typical middle-sized mixed crop farm in North Florida. Cumulative probability distributions of different farm plans are subjected to stochastic dominance analysis to determine risk-efficient plans for different groups of farmers.

The results show that farmers behave differently in their choice of farm plans according to their risk attitudes. Highly risk-averse farmers, for example, choose forward contracting marketing strategy while low risk-averse and risk-loving farmers are inclined to use cash sales at harvest time and futures options strategies. The reduction in acreage allotment devoted to peanuts under the federal government crops program leads to a significant reduction in farm income even when the acreage replaced is planted with either corn, soybeans or wheat. The use of the futures market by the farmer leads to both higher income and higher risk than forward contracting. However, this use results in less income and lower risk than the cash sales at harvest time marketing strategy.

# CHAPTER 1
# INTRODUCTION

## The Problem Statement

Agriculture is the most important sector of the economy of Florida after tourism and the state has consistently ranked among the top 15 states in total farm cash receipts in the United States. Another indicator of the importance of the agricultural sector for state revenues is the growth of agricultural exports. According to Greene et al. (1980, page 3), Florida's total agricultural and fishery exports increased from $284 million in 1975 to $529 million in 1979.

The increasing production and value of Florida's agricultural products, however, have not been accompanied by income stability for producers. Income instability of farmers has been a marked characteristic of the 1970s and 1980s. Producers' net income variability can be attributed to several factors. First, an increasing reliance on foreign trade exposes the economy of Florida to the fluctuations of international prices of agricultural products and to the inherent instability in the world market conditions. The 1970s and early 1980s also saw a very rapid rise in energy prices. From an average of $2.18 per barrel in 1971, the price of crude oil rose to an average price of $35.00 in 1981 before declining to about $30.00 in March 1983 (Marbach et al., 1983, pp. 62-65). Since Florida's farm production is heavily dependent on the use of fossil fuels, income instability of producers became a greater reality in the 1970s and early 1980s partly for this reason. Freezes, droughts, and other natural causes have also created production instability affecting the income of producers. The freezes of 1977, 1980-82, affected citrus, vegetable, and other farmers in the state. Also, the recent droughts in 1981, 1983 and 1985 affected many farmers. Given the rapid changes in the economic and natural environment facing farmers, formal analysis of the components and sources of farm management risk and uncertainty becomes increasingly important. An understanding of risk will aid farmers and policy makers in formulating more reliable strategies to hopefully increase and stabilize farm incomes.

Another major reason for seeking to understand farm risk is the increasing number of farm foreclosures and bankruptcies, which reached a peak in 1982 for the United States and Florida since the 1930s ("The Farmers Fight," 1983). The same source notes that Farmers Home Administration loans' delinquency rate nationwide jumped to 24 percent in 1982 from a rate of 7 percent in 1978. The rate of agricultural bankruptcies increased from 3.8 per 100,000 farms in 1949 to 26.3 in 1978 and 1982 rates approached those of the Depression era in the 1930s (Shepard and Collins, 1982).

According to a recent publication ("Agricultural Report," 1985), current farm conditions in many states of the Union have reached crisis proportions. Ninety-three thousand mid-sized U.S. farms holding $47 billion in debts are regarded as either technically insolvent or on the verge of reaching that stage soon. The same publication indicates that about 386,000 of the 2.3 million farms nationwide or nearly 18 percent may be suffering from some financial stress. This fact is compounded by the fact that total agricultural debts of the United States increased to $214 billion in early 1985.

The reasons for the current financial problems in agriculture are varied. One of the more critical factors has been the low levels of producer prices nationwide. In several cases, farmers have been unable to pay back loans because of long periods of drought, emphasizing that the delinquency rate and income instability may be due, among other things, to lower producer prices and also high interest rates. Other reasons include increases in the costs of production due to inflation, declines in farm real estates values and high real interest rates.

From an aggregate analysis of the U.S. farm economy, Shepard and Collins (1982) observe that increasing farm size and variation in farm income are among the major factors affecting farm bankruptcies after the Second World War. Recessions in the national economy also contribute to bankruptcies.

Government policies have sometimes caused problems of income instability for farmers. For example, the 1973 Nixon Administration cattle and the 1974 Ford Administration wheat and soybeans export controls both affected the incomes of farmers while seeking to preserve low food prices for consumers. More recently, the 1980 Carter Administration export embargo of grains against the Soviet Union resulted in a declining share for the United States in the world grains trade affecting farmers. The high value of the U.S. dollar from 1983 to 1985 has also led to the decline of farm exports. The high value of the dollar is partly the result of high federal government deficits which lead to high real interest rates which, in turn, attract foreign money to the U.S. and make U.S. exports relatively expensive.

While income instability has been a general problem in most farming areas of the United States, different areas have had their special problems. North Florida (the area of the study, Figure 1-1) and its surrounding areas such as South Alabama have been particularly characterized by grave financial difficulties of farmers in the 1980s (Agricultural and Credit Outlook, 1983).

Farm risks faced by the mixed crop and livestock farmers in this area depend to a large degree on the resource and climate conditions of the area. The growing season is long, but the winters are too cold for citrus or winter vegetables. The summer months are warm, wet and humid providing an excellent environment for insects, weeds and diseases. Despite the fact that the area receives nearly 60 inches of rainfall yearly, availability of water is a frequent problem on the extremely sandy soils which are relatively common in the area because of their very low water holding capacities.

Compounding these biological and climatic problems is the region's distance from and lack of ready access to major crop and livestock markets. The region can be regarded as part of a "fringe" agricultural area between the major Corn Belt producing area to the north, wheat, cotton and cattle operations to the west and the high-valued citrus and vegetable production to the south. Peanuts and tobacco are the two most profitable crops primarily because they have been protected by the federal government acreage restrictions and guaranteed price programs. But, the recent declaration by the federal government that it intends to move towards more free-market agricultural policies suggests that the relatively high and stable prices for peanuts and tobacco may be a casualty thus exposing farmers in this

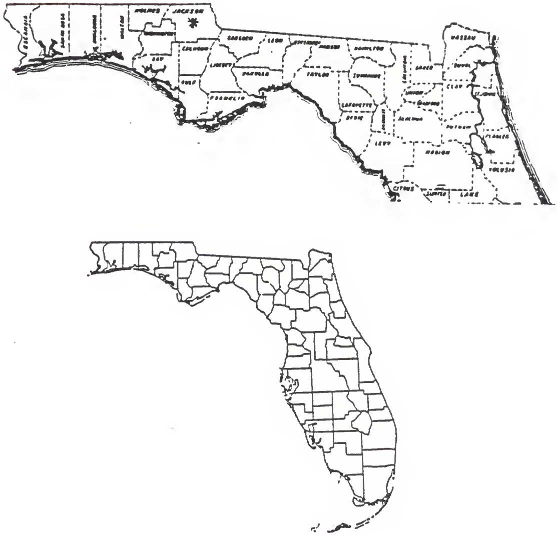


Figure 1-1. Map of Florida Showing North Florida Counties Including Jackson County, the Area of the Study.

area to even more income instability. The need exists, therefore, to examine the income potential of alternative marketing and production strategies available to the farmers in the area to evaluate their profitability and risk.

It is generally recognized that under conditions of near bankruptcies and wide income instability, survival of farmers becomes a more important goal vis a vis short-run profits maximization or long-run wealth maximization. Strategies for reducing income variability of farm producers need to be investigated within the current economic environment to provide insights on the potential for farmers to strengthen their financial position and reduce income instability.

While it is clear that risks play a major role in agriculture in this area, little is known about producers' perceptions of risks issues. Hence farmers' own perceptions of risk and management responses towards risk need to be evaluated as a starting point in deriving strategies that can help reduce income instability and be acceptable to the farming population.

## Objectives of the Study

In the light of the above factors and concerns, the objectives of the study are

(a) to conduct a survey to determine the major sources of risk, farmers' perceptions of risks and their management responses to risks in crop and livestock production;

(b) to determine the important socioeconomic characteristics that influence farmers perceptions toward risk and the use of management responses to combat risks; and

(c) to evaluate the efficiency of various risk-management scenarios for different groups of farmers classified according to their risk attitudes.

## Organization of the Study

Chapter 2 summarizes literature directly related to the study. Analytic tools used to derive the results and conclusions are described with regard to the theory and their limitations. Chapter 3 offers a detailed description of the methods and procedures. The basic hypotheses to be tested in relation to the objectives of the study are emphasized.

Chapter 4 reports the results of the farm risk-survey analysis. Chapter 5 then presents the results obtained from the stochastic modeling analysis of a typical farm in North Florida with regard to the risk-efficiency comparisons of various simulated risk-management scenarios.

Chapter 6 gives a brief summary of the study and reports the conclusions. Specific recommendations, policy implications, limitations of the study and suggestions for further research are also discussed. The appendices contain the risk-survey questionnaire, the simulation model used to generate the income distribution of different risk-management scenarios and other information used in the analyses.

# CHAPTER 2
# LITERATURE REVIEW

## General Review of the Farm Risk Literature

Risk and uncertainty as currently used in most of the farm management and production economics literature denote the same thing. They are used for probabilistic outcomes where the probabilities of the outcomes are known either "subjectively" or "objectively," or both. "Objective" estimation of probabilities involves the use of historical data and frequencies while "subjective" probabilities involve intuition and experience, in their estimation.

In real life, probabilities are estimated by most farmers using both "subjective" and "objective" means. Differentiation between risk and uncertainty (risk where frequency data are available and uncertainty where no frequencies are known), as formally done by Knight (1922), is not appropriate under most farm management conditions. All information is subjectively perceived, measured and interpreted, making differentiation of risk and uncertainty ambiguous. Hence all probability measures can be considered subjective (Robison and Fleisher, 1983).

Risk has sometimes been defined in terms of "hazard" and the probability of "loss." This definition of risk is reflected in the minimum level of income needed by the farmer as emphasized by de Janvry (1972, pp. 234-237) under farm conditions. This definition appears restrictive in the sense that it excludes the possibility of favorable outcomes.

The traditional neoclassical farm-firm theory asserts that the farmer maximizes expected profits or net income by allocating his resources in a riskless, competitive environment. The theory of the farm-firm is basically a conceptual model which hopes to explain how farmers behave. It has been modified to include location and transportation costs and also time preferences. The assumption of a riskless economic environment is unrealistic and incorporation of risk into the decision making model can affect conclusions derived from this static theory of the farm-firm. Hazell (1982, p. 384) stresses that the neglect of risk-averse behavior in models explaining farmers' behavior can lead to overstatement of output levels of producers. Sandmo (1971, pp. 65-73), in analyzing the quantity setting firm under demand price uncertainty such as occurs in farm production, establishes the well known fact that competitive risk-averse firms will produce less output under risky situations than under a riskless environment. Similar conclusions are derived for production occurring under production uncertainty due to weather and labor supply breakdown.

Feder et al. (1980) have extended the theory of the farm-firm under price uncertainty to incorporate the futures markets. They argue that once futures marketing trading is possible, the production decisions become independent of the distribution of the uncertain price. Production is shown theoretically to depend on the prevailing futures prices if output is assumed to be non-random. Irrigated crops where output is much more certain at the time of planting may approximate the situation of non-random production in agriculture. Methods of reducing farm income instability may, therefore, depend on the reduction of price uncertainty by the use of futures trading and the reduction of production uncertainty by strategies such as irrigation.

Risk is sometimes incorporated in static production models based on the assumption that the farmer chooses inputs to maximize the mathematical expectation of the utility of net income given the random price and output. A general characteristic of static models is that revenues are considered uncertain but the costs certain because farmers are assumed to choose their set of inputs before production takes place.

However, some agricultural inputs are used throughout the growing season, for example irrigation water, pesticides and labor inputs. Antle (1983) has argued for the use of dynamic production models to address the multi-stage or multi-period farm decision problems. Dynamic production models have a recursive structure, the production functions are non-linear and the costs of inputs uncertain as against the certainty of costs in static models. Risk-neutral dynamic production models indicate that risk or uncertainty does affect optimal resource allocation. Hence, as Antle (1983) states, all farmers whether risk averse or not could gain from information about price and production risk.

Considerable theoretical and empirical risk research exists. Firm growth models now incorporate production, marketing and financial risks (Hanson et al., 1984, pp. 173-182). Risk has also become a key factor in financial analysis of farms (Barry, 1983).

Several analytical models have been used to explain farmers' behavior under risk and uncertainty and also to quantify and measure risk. Five main approaches to the empirical analysis of farm-firm risk predominate the literature. These approaches include the expected utility theory, stochastic dominance rules, safety first methods, game theoretic models and goal programming.

The expected income-variance of income analysis as an approximation to the expected utility theory was pioneered by Markowitz (1959) and Tobin (1958). Recent use of the expected utility theory has concentrated on small farmers in less developed countries and indicates that risk aversion is prevalent among farmers in those areas. Herath et al. (1982) employ the expected utility model using single attribute and multiple attribute utility maximization to study the risk-aversion behavior among farmers in Sri Lanka. The single attribute utility maximization involving total income of farmers appears to do as well as multiple attribute utility maximization where the goals of the farmer have been expanded to include profits or income and subsistence consumption. English and Orlob (1978) also have used the concept of expected utility maximization rather than maximization of expected profits with good results for some irrigated farms in California.

The use of the expected utility maximization approach to model and measure farmers' behavior poses several problems as have been emphasized by Anderson et al. (1977) and Dillon (1977). These problems include the obvious difficulty and high costs that are required to elicit utility functions directly from individual farmers as a step to determining optimal behavior. Farmers' utility functions may also change over time and considerable efforts are required to capture the dynamic effects (Anderson et al., 1977).

A second approach is to use Monte Carlo simulation techniques to determine the cumulative probability distributions of income for alternative farm plans. Risk-efficient plans can then be identified using stochastic dominance procedures. The theoretical and measurement problems involved in the use of this approach have been analyzed by Anderson et al. (1977), Dillon (1977) and Hadar and Russell (1974) among others. This approach requires more sophisticated procedures than other approaches. Obtaining sufficient data to describe the entire probability distribution may be difficult. However, sparse data procedures may be helpful, whereby a few data points are extrapolated to represent the entire probability distribution (Mood and Graybill, 1963, p. 405).

The stochastic dominance approach has the advantage of establishing probability or cumulative probability levels of obtaining critical income levels by farmers. In addition, this approach may not require elicitation of farmers' utility functions. The stochastic dominance approach has been widely used by agricultural economists to identify efficient choices such as participation in government programs by farmers, evaluating the use of information in making agricultural decisions, crop variety coice, policy choice, machinery selection, adoption of the production technology and choice of irrigation strategy (Kramer and Pope, 1981; Kiker and Bauman, 1984).

Safety first models are a third approach for analyzing farm-firm risk at the empirical level. These methods have been developed as alternative models for explaining the economic environment where the survival of the farm business is critical. The rationale is that the farmer seeks a certain minimum level of income for reasons such as fixed loan payments or subsistence food requirements. A variety of models have been developed to address this concept. Some of the models seek to minimize the probability of expected income falling below critical or "hazard" levels. Boussard and Petit (1967, pp. 869-880) have incorporated safety first constraints by the specification of a minimum desired level of income via linear risk programming. Berck and Hihn (1982) indicate several problem areas in the measurement and modeling of farmers' goals and suggested several techniques to deal with those problems. Patrick and Blake (1980) use semi-variance to estimate safety-first constraints.

Stochastic game models are a fourth approach used to analyze farm management behavior under uncertainty. These models normally employ the two-person, zero sum game. Nature is often regarded as the opponent of the farmer in the game model. The worst possible total net returns that nature can inflict is a possible solution. Gould and Ferguson (1980, pp. 332-333) assert that the game theoretical model is unnecessarily conservative because it seeks the best of the worst possible situations and appears to be incompatible with the dominant entrepreneurial psychology. However, in farm situations where survival is critical, the game theoretical model may present a reasonable alternative analytic tool. The inherent assumption that nature is in direct opposition to the farmer's objectives may not hold.

Goal programming models incorporate several goals of the farmer in addition to profit maximization in whole farm planning. The basic idea is to establish a numerical goal for each of the objectives, formulate an objective function for each and then seek a solution that minimizes the weighted sum of deviation of the objective functions from their respective goals (Hiller and Libermann, 1980, p. 172). Barnett et al. (1982) use a multiple objective goal programming model for Senegalese semi-subsistence farmers in West Africa.

The incorporation of safety-first constraints through minimum or critical income levels required by farmers coupled with Monte Carlo simulation and stochastic dominance analysis is felt to be the most appropriate method of addressing the third objective of the study. Stochastic dominance and simulation analysis are used to establish cumulative probability distributions of different farm plans while safety first constraints are emphasized through critical income levels needed by farmers. The first and second objectives are met through the analysis of farm risk survey data.

## Review of Analytic Methods and Tools Used in the Study

### Utility Theory of Risk

The utility theory of risk states that a utility function exists for a decision maker whose preferences are consistent with the axioms of ordering and transitivity, continuity and independence. The utility function associates a single real value with any risky project. The individual will always choose the project that yields the highest mathematical expectation of the utility function of some outcome. The outcomes of the utility function could be income or wealth, time streams of consumption or purely non-numerical consequences, for example, a visit to Africa. The mathematical expectations are based on the subjective probabilities of outcomes.

If the individual is risk averse which is the accepted norm of behavior for most farmers under many conditions, then his utility of income increases at a decreasing rate as shown in Figure 2-1. Figure 2-1 shows two possible outcomes $Y_1$ and $Y_2$ resulting from two states of nature if a particular project or farm plan (A) is selected.

The expected monetary value (EV) of any farm plan or project is the mean of the outcomes of the project. Hence the EV is just the sum of the product of the income and probabilities for each possible outcome. The certainty equivalent (CE) is the level of income which if received with certainty yields the same level of utility as the uncertain project (EU(A)). If the decision maker is risk averse, the CE will always be less than the EV. The difference between the expected value and the certainty equivalent is the cost of risk reduction or the cost of risk as used in the literature. The cost of risk has been determined to be a function of income by Pratt (1964) as follows for small risks:

$$C = \frac{-U''(Y)}{2\,U'(Y)} \text{ var } (Y)$$

where C is the cost of risk, U" is the second derivative of U(Y), U' is the first derivative of U(Y) and var (Y) is the variance of income. The cost of risk is the basis for the producer's willingness to accept a reduction in expected income in return for a reduction in variability or risk. The cost of risk is directly proportional to the variance of income indicating that a farm plan with higher variance entails a higher cost of risk. The cost of risk (C) is also a direct function of (-U"/U') which is termed the absolute risk-aversion coefficient

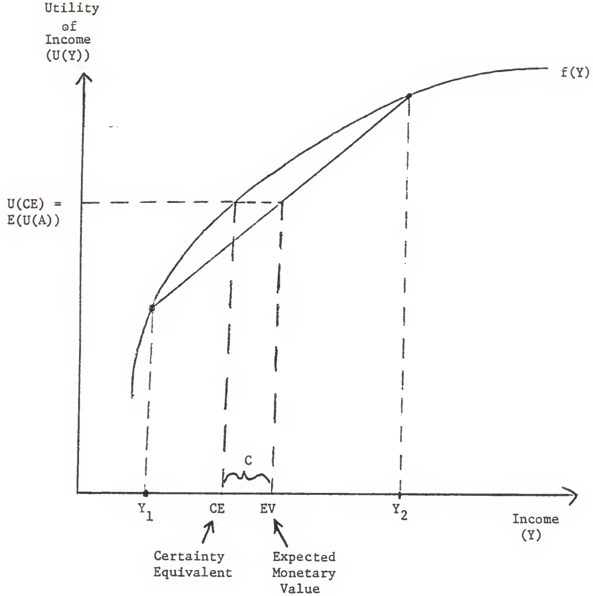


Figure 2-1. Diagramatic Representation of Risk Aversion and the Cost of Risk.

(Pratt, 1964). The absolute risk-aversion coefficient is an individual characteristic and therefore varies from one individual to another. Hence a farm plan with the same variance of income may be perceived differently by farmers with differences in the degree of risk aversion. The degree of absolute risk aversion for an individual farmer may depend on characteristics such as the level of experience in farming, size of the farm, the types of agricultural commodities produced, financial status of the farmer, educational level and the reliability and strength of the support system behind the farmer. Hence a survey of farmers to determine the sources of risks, their perceptions of risks and management responses may be important in understanding farm risk.

The utility theory of risk was pioneered by von Neumann and Morgenstern (1947). The dissatisfaction with the theory has been increasing in recent years. Borch (1968) has discussed several experiments that have been done to test the expected utility theory in general. The axioms of transitivity and continuity have sometimes been rejected in experimental work by psychologists and economists. However, their validity seems appropriate under many conditions. The independence axiom has come under the most severe attack and appears to have been clearly refuted by several studies (Allais and Hagen, 1979; Machina, 1985; Morrison, 1967; Raiffa, 1968).

The independence axiom basically states that the evaluation of a risky project is not affected if some element in the project is replaced by another element with which the decision maker is indifferent. In other words, preferences occur independently of successive probability resolutions. Hence if a farmer preceives project $P_1$ as indifferent (preferred) to $P_2$ and $P_3$ is any other risky project, then a lottery with $P_1$ and $P_3$ as its outcomes will be perceived as indifferent (preferred) to a lottery with $P_2$ and $P_3$ as outcomes if the probabilities of $P_1$ and $P_2$ occurring are equal. With the persistent attacks on the independence axiom, the defense of the utility theory of risk seems to have shifted to the analytic power and the ability of the theory to generate "correct" predictions and implications rather than on the perfection of its underlying axioms.

Machina (1982), however, has demonstrated that the basic concepts, tools and results of utility theory do not depend on the independence axiom, but may be derived from the weaker assumption of smoothness of the preferences over alternative probability distributions. Thus while the independence axiom may not be empirically valid, the implications and predictions of the studies which use expected utility analysis will be proved if the preferences are smooth and hence the preference function can be differentiated in the appropriate sense. The individual is then assumed to be maximizing a fixed preference function defined over the alternative probability distribution over wealth. Hence while making only the assumptions of continuity, transitivity and smoothness, the essential concepts and conclusions of expected utility analysis are maintained without having to make the assumption of the independence axiom.

## Logistic Regression

The probability of the use of a certain risk-management response by a farmer can be assumed to be related to his socioeconomic characteristics such as education level, experience in farming and financial status of the farm. This assumption is based on the argument that the degree of risk aversion for an individual farmer depends on several factors including certain socioeconomic factors. A farmer's use of risk-reducing management responses depends on the degree of risk aversion and hence influenced by certain socioeconomic factors. The relationship between the probability of use of a certain risk-management response and socioeconomic characteristics can be modeled as a simple linear relationship as follows:

$$\pi_i = X_i'B$$

where $\pi_i$ is the probability of the use of a certain risk-management response i, and $X_i'$ is the transpose of the matrix of the socioeconomic characteristics and B is the matrix of parameter estimates.

If the above equation is estimated by the method of ordinary least squares, it is likely to run into difficulty with extreme values of $X_i'B$ since the estimated probabilities may turn out to be negative or in excess of unity thus defying the basic laws of probability. The most common procedure used to estimate these probabilities is logit or logistic regression which overcomes the weakness of estimation by ordinary least squares technique.

The logistic method is formulated as follows using the notation employed by Johnston (1984, pp. 425-428):

$$\pi_i = \frac{e^{X_i'B}}{1 + e^{X_i'B}} = \frac{1}{1 + e^{-X_i'B}}$$

The above equation constrains the probabilities to the (0,1) interval to be consistent with the laws of probability. The curve traced from the equation increases monotonically with increases in $X_i'B$. It follows that

$$\ell n \frac{(\pi_i)}{(1 - \pi_i)} = X_i'B$$

where $\ell n$ is the natural logarithm. Estimating $\pi_i$ as $p_i$, it can be proved that $p_i$ follows a binomial distribution with mean $\pi_i$ and variance $\pi_i(1 - \pi_i)/N_i$ where $N_i$ is the sample size. The relationship to be estimated from the sample proportions becomes

$$\ell n \left(\frac{p_i}{1 - p_i}\right) = X_i'B + U_i$$

where $\ell n$ $(p_i/1 - p_i)$ is the odds favoring the use of a certain risk-management response i and U is the error term, assumed to be normally distributed with mean zero and variance $1/N_i \ \pi_i(1 - \pi_i)$. Theil (1971, pp. 632-635) and Johnston (1984, pp. 425-428) have established that the equation can be estimated by maximum likelihood procedures such as the SAS Funcat and Logist Statistical Procedures (SAS, 1982).

## Stochastic Dominance and Risk Efficiency

Stochastic dominance methodology is an efficiency criterion used to order or rank choices. This applies for a particular group of decision makers and divides the decision alternatives into two mutually exclusive sets: an efficient set and an inefficient set. The efficient set contains the preferred choice of every decision maker whose preferences are consistent with the restrictions imposed by the criterion. Inefficient alternatives are not considered because no element in the inefficient set is preferred by any of the decision makers. There are several versions of the stochastic dominance methodology and these are discussed below.

Given any two probability distributions of income f(y) and g(y) defined over the relevant range (a-r) and defining cumulative probability distributions $F_1(Y)$ and $G_2(Y)$ as follows:

$$F_1(Y) \;=\; {}_a\int^r f(y)\,dy; \qquad G_1(Y) \;=\; {}_a\int^r g(y)\,dy$$

then farm plan F is stochastically more efficient than farm plan G if $F_1(Y) \leq G_1(Y)$ for all possible r. This type of stochastic efficiency is termed first degree stochastic dominance. First degree stochastic dominance of f(y) over g(y) establishes only that f(y) is preferred over g(y) by the type of decision maker whose marginal utility for income is positive or, in other words, prefers more income to less.

Second degree stochastic dominance (SSD) rule provides a more powerful tool to evaluate different farm plans and management strategies. The rationale behind the SSD rule is that the decision maker has both a positive and a diminishing marginal utility for income, illustrating risk aversion which is generally accepted as the norm of behavior for most farmers. The SSD rule can be stated in terms of the cumulative probability functions. The distributions $F_2(Y)$ and $G_2(Y)$ are defined as follows:

$$F_2(Y) \;=\; {}_a\int^r F_1(Y)\,dy; \qquad G_2(Y) \;=\; {}_a\int^r G_1(Y)\,dy$$

If $F_2(Y) \leq G_2(Y)$ for all possible r, then farm plan F is more risk efficient than farm plan G.

Two additional dominance rules have been used to determine risk-efficient plans. They are (a) third degree stochastic dominance and (b) convex stochastic dominance. The third degree stochastic dominance (TSD) rule is based on an additional assumption that the third derivative of the farmer's utility function is positive. In other words, it assumes that as farmers become wealthier, they become less averse to risk (Dillon, 1977, p. 288).

Defining the area under the second degree stochastic dominance cumulative function for farm plans F and G as follows:

$$F_3(Y) = \int_a^r F_2(Y)\, dy \quad \text{and} \quad G_3(Y) = \int_a^r G_2(Y)\, dy$$

then the distribution F is stochastically more efficient than G in the sense of third degree stochastic dominance if $F_3(Y) \leq G_3(Y)$ for all possible r.

Convex set stochastic dominance (CSD) involves evaluating convex combinations of several cumulative probability distributions (CPD). It has been developed as an improvement over the first degree, second degree and third degree stochastic dominance rules. These latter three risk-efficiency criteria all involve pairwise comparisons of the alternative management scenarios thus imposing a consensus requirement. Hence each pairwise comparison is done without the advantage of the information from the other comparisons thus leading to a larger efficient set.

Convex stochastic dominance relaxes the consensus requirement by comparing the expected utilities of say, an alternative scenario G and some convex combinations of other alternative scenarios, $K_iF_i$ in order to reduce the risk-efficient set. This procedure results in a risk-efficient set which has as its members only those scenarios which have the highest expected utility for at least one decision maker (utility function) in the specified class. Cochrane et al. (1984) have developed an algorithm that can be used to implement the convex stochastic dominance rules.

Meyer (1977) has generalized the stochastic dominance theories in such a way that the first and second degree stochastic dominance rules become special cases. The generalization is called the stochastic dominance with respect to a function. Under this technique, classes of decision makers are defined by specifying lower and upper bounds on their absolute risk-aversion coefficient (A(Y)). The absolute risk-aversion coefficient is defined as

$$A(Y) = \frac{-u''(y)}{u'(y)}$$

where $u''(y)$ and $u'(y)$ are the second and first derivatives of the utility function of income $u(y)$. The level of absolute risk aversion indicates whether the farmer is risk averse or risk lover. A negative value implies risk-loving behavior while a positive value indicates risk aversion.

The lower and upper bounds on the farmer's absolute risk-aversion coefficient $A_1(Y)$ and $A_2(Y)$ define an interval measurement of his or her preferences. Second degree stochastic dominance is a subset of this larger class where $A_1(Y) = 0$ and $A_2(Y) = \infty$. First degree stochastic dominance then implies that $A_1(Y) = -\infty$ and $A_2(Y) = \infty$. Risk neutrality occurs when the lower and upper bounds of the risk-aversion coefficient are equal to exactly zero. Risk neutrality implies that the farmer maximizes expected profits or income. Hence the traditional neo-classical theory of the farm-firm which assumes that the farmer maximizes expected profits can be considered a subset or a special case of the generalized risk theory of the behavior of farmers based on the expected utility theory and operationalized by stochastic dominance with respect to a function. Specification and elicitation of the absolute risk-aversion coefficients intervals can be done by procedures developed by King and Robison (1981) and Love and Robison (1984).

The theoretical basis of stochastic dominance with respect to a function is now described (Meyer, 1977a). Given a set or a group of farmers or decision makers, it can be evaluated whether all persons in the group prefer one cumulative distribution of net income F(Y) to another G(Y) or are indifferent. If F(Y) is preferred to G(Y) for all permissible A(Y) then it can be concluded that

$$\int_0^1 u(y)\ f(y)\ dy - \int_0^1 u(y)\ g(y)\ dy = \int_0^1 u(y)\ (f(y) - g(y))\ dy > 0$$

where f(y) and g(y) are the probability density functions defined over the range of the random variable specified here as (0,1). Integrating the above equation by parts, it can be proven that

$$\int_0^1 u(y)\ (f(y) - g(y))\ dy = \int_0^1 (G(y) - F(y))\ u'(y)\ dy$$

If the above equation is minimized over A(y) and is positive, then all farmers for whom $A_1(y) \leq A(y) \leq A_2(y)$ prefer F(y) to G(y). The whole problem becomes one of optimal control defined as follows where u'(y) is the state variable and A(y) the control variable.

$$\text{Maximize} \quad -\int_0^1 (G(y) - F(y))\, u'(y)\, dy$$

Subject to the equation of motion

$$(u'(y))' = u'(y)\,(u''(y)/u'(y))$$

and the constraints on the control as

$$(-u''(y)/u'(y)) - A_1(y) \geq 0$$
$$(u''(y)/u'(y)) + A_2(y) \geq 0$$

and the initial condition as $u'(o) = 1.0$. The solution to the control problem establishes whether $F(y)$ is preferred or is indifferent to $G(y)$ by all farmers in the class determined by the absolute risk-aversion coefficient intervals $A_1(y)$ and $A_2(y)$. The control problem is solved by the bang-bang principle meaning that the solution value of the control variable $A(y)$ is either the lower or upper bound. The objective functional is non-negative if $F(y)$ is preferred to $G(y)$.

This stochastic dominance generalization can be utilized for both continuous and discrete probability distributions. Hence where there are a few finite farm plans to be ranked or discriminated for risk efficiency as in this study, this method is indeed a powerful tool. This approach allows for the ranking of farm plans that could not be ranked by second or first degree stochastic dominance rules.

The major disadvantage of this method is the requirement of direct elicitation of the absolute risk-aversion coefficient from farmers. Results obtained may be inaccurate and may change over time. Love and Robison (1984, pp. 159-166) have analyzed the inter-temporal stability of farmers' risk preferences and conclude that risk preferences are rather stable over the income ranges that are typically experienced by farmers. However, they also conclude that risk preferences may not be inter-temporally stable over wide ranges of incomes.

Secondary data and other published studies may be used to establish the absolute risk-aversion coefficient intervals. Safety-first constraints in the form of minimum or critical incomes farmers must achieve may be incorporated with the stochastic dominance with respect to a function method for analysis. The farmer's chances of incomes falling below the critical income may then be estimated and used as a crude guide as to the riskiness of the farm plan. The critical income may be the income level needed to pay back short-term debts and obligations or the income necessary to maintain a certain standard of living.

In operationalizing the stochastic dominance with respect to a function concept, Meyer (1977) uses the following utility function of income as an adequate representation of the individual farmer's utility function of income.

$$U(Y) = e^{-\lambda Y}$$

where Y is the income, U(Y), the utility function of income and $\lambda$ the absolute risk-aversion coefficient. Representing $U'(Y)$ and $U''(Y)$ as the first and second derivatives of the utility of income (U(Y)), it can be shown that $\lambda = -U''(Y)/U'(Y)$. Meyer's operationalization of the stochastic dominance theorems, therefore, seems to indicate that the absolute risk-aversion coefficient ($\lambda$) is constant. However, the lower and upper bounds indicate that the coefficient can vary over the interval for an individual farmer.

The assumption of a constant absolute risk-aversion coefficient derived from the function $U(Y) = e^{-Y}$ has led to the development of several different forms of utility functions. These functions include the decreasing absolute risk-aversion stochastic dominance (Vickson, 1977). The criterion of a decreasing absolute risk-aversion coefficient is consistent with the third degree stochastic dominance rule proposed by Whitmore (1970). Both are consistent with the argument that the absolute risk-aversion coefficient should be a decreasing or at least a non-increasing function of income or wealth. This argument is supported by the recent empirical work by Love and Robison (1984) indicating that the absolute risk-aversion coefficient may not be inter-temporarily stable over a wide range of incomes.

Vickson (1977) defines the decreasing absolute risk-aversion coefficient class of utility functions as

$$U'(y) \quad = \quad U'(b) \exp(- \int_{b}^{y} r_u(y)\, dy)$$

where $U'(y)$ is the first derivative of $U(y)$, $U'(b)$ is the value of the derivative at a fixed income level b, $r_u$ is a non-negative, non-increasing piecewise smooth function. Since $U'(b)$ is positive by definition because farmers are assumed under this theorem to prefer more income to less, then the decreasing absolute risk-aversion coefficient class of functions can be proven to be non-decreasing, concave with convex first derivatives. Hence they are a subset of the utility functions that are associated with the third degree stochastic dominance theorem proposed by Whitmore (1970).

Flood et al. (1985a) have described the differences between the third degree stochastic dominance class of functions and those of the decreasing absolute risk-aversion coefficient stochastic dominance including the special algorithm needed to apply the latter concept. Recently, the same authors, Flood et al. (1985b) have extended the viability of the decreasing absolute risk-aversion coefficient stochastic dominance theorem by incorporating into the theorem the lower and upper bound intervals of the absolute risk-aversion coefficient of Meyer's stochastic dominance with respect to a function. They call this hybrid the restricted absolute risk-aversion stochastic dominance.

The restricted absolute risk-aversion stochastic dominance appears to be a slight improvement of Meyer's stochastic dominance with respect to a function because the latter does not explicitly include third degree stochastic dominance or the concept of decreasing absolute risk-aversion coefficient. Initial results from the use of the restricted absolute risk-aversion stochastic dominance suggest that it is a more powerful tool to descriminate among potential farm plans than either Meyer's stochastic dominance with respect to a function or Vickson's decreasing absolute risk-aversion stochastic dominance.

In this study, however, the stochastic dominance with respect to a function (Meyer) is used to determine the risk-efficient farm plans or risk-management scenarios. This is because the technique has been more widely used and validated in agricultural economics than any other stochastic dominance tools. Its power of discrimination is found to be adequate for the analysis of this study.

## Simulation Modeling

Simulation modeling involves building an experimental model of a system and evaluating the various alternatives in reference to their performance in the test runs of the model (Wagner, 1969, pp. 887-891). A simulation model is a simplified representation of the real world which aims to capture the essential features of what is being modeled without the complexities of its less significant aspects. A simulation model may be constructed for several purposes including describing a current system, exploring a hypothetical system and to design an improved system. In this study, the simulation model developed is representative of the current farming system. Evaluation and sensitivity analysis are done to derive risk-efficient management practices or farm plans based on the different risk attitudes of farmers.

Following Dent and Blackie (1979, pp. 13-19) and Csaki (1985) the basic steps in agricultural systems simulation are listed as follows:

(a) definition of the system and statement of objectives;
(b) collection and analysis of relevant data;
(c) model construction;
(d) validation of the model;
(e) sensitivity analysis; and
(f) application of the model.

The inclusion of stochastic elements in simulation models is often crucial, especially when analysis of farm risk and uncertainty is a major objective. Stochastic elements in simulation models are created through the selection of random variables from some defined probability distributions which best represent the natural occurrences generating the data. Some common probability distributions used in simulation modeling are described in Table 2-1.

The six basic steps involved in agricultural systems simulation are followed closely in this study. The first step, definition of objectives, is incorporated in Chapter 1. Collection of and analysis of relevant data in the model construction are described in Chapter 3. The validation of the model and sensitivity analysis are reported in Chapter 5, while the conclusions and the applications of the model are presented in Chapter 6.

Table 2-1. Common Probability Distributions Used in Simulation Modeling

| Type | Description | Application in Agricultural Economics |
|---|---|---|
| Uniform | The uniform probability distribution indicates that every value between the minimum and the maximum is equally likely. This distribution is likely to be used in situations of almost complete lack of knowledge concerning a random variable except that it is between a minimum and a maximum. | a. Modeling expected income distribution<br>b. Agricultural project analysis incorporating risk (Anaman, 1981) |
| Triangular | Three values are specified in this distribution. They are the minimum, maximum and the mode. The probability function consists of two parts--one increasing from the minimum to the mode value and the other from the mode to the maximum value. In an analysis of a model, if the three values--minimum, mode and maximum--can adequately represent the distribution of the random variable, then it is good to use this distribution. | a. Agricultural projects analysis (Anderson et al., 1977, pp. 267-272) |
| Binomial | The binomial distribution is a discrete distribution. It may be used when the sample is obtained using either of the following procedures: (a) sampling from an infinite population, (b) sampling from a finite population with replacement. The researcher is dealing with binomial variables when the experiment consists of a mixed number of statistically independent trials and each trial results in either a success with a probability (p) or failure with a probability (1 - p). The probability density function of a binomial distribution is given as $f(k) = \genfrac{}{}{0pt}{}{n}{k} p^k (1 - p)^{n-k}$ where k is the number of trials. | a. Quality control in agricultural processing. Can be used to estimate defective items in a batch of goods |

Table 2-1. Continued

| Type | Description | Application in Agricultural Economics |
|---|---|---|
| Poisson | A discrete distribution that describes the number of outcomes of the random variable during a specified period of time. It is an adequate approximation to the binomial distribution especially when the probability of occurrence (p) is very small and the number of occurrences (n) is very large. | Quality control in agricultural processing |
| Normal | Most widely used probability distribution. This distribution may be used by invoking the central limit theorem which states that the distribution of the sum or average of n independent observations from any distribution approaches a normal distribution as n gets larger. | Modeling of prices and yields distribution |
| Beta | The beta distribution is defined over a finite range and can take on a variety of shapes. This distribution concentrates all of the probability mass between zero and one, curves can be skewed to the right or to the left or even be symmetric depending on the choices of the parameters. | Risk analysis for agricultural projects (Valencia, 1982) |
| Gamma | This is a continuous distribution which can have many forms. All of the probability mass is betwen zero and infinity indicating the random variable is positive. It is heavily skewed with the tail on the right drifting into infinity. A special case of the gamma distribution is the exponential distribution. | a. Growth curve of livestock used to determine nutrient requirements (Melton, 1978; Abassa, 1984)<br>b. Growth rates of crops<br>c. Forecasting crop yields |

Table 2-1. Continued

| Type | Description | Application in Agricultural Economics |
|---|---|---|
| Negative Binomial | Discrete distribution defined in the integer 0,1--infinity. The probability density function is as follows: $\binom{n-1}{k-1} p^{k} q^{n-k}$ where $k \geq 1$ and $n \geq k$, n is the number of trials and k is the number of successes. The probability of success is p and 1 - p is the probability of failure. We are interested in finding the probability of the kth success in n trials. This assumes there must be k - 1 successes on the first n - 1 trials. When k = 1, this becomes the special case known as the geometric distribution which has a probability density form $pq^{n-1}$. | a. Distribution of different sized trunks in forestry (Eidman, 1971, p. 20)<br>b. Marketing (Ehrenberg, 1972) |
| Log-normal | This is a distribution of a random variable whose natural logarithm indicates a normal distribution. The central limit theorem indicates that the distribution of the product of independent positive random variables comes close to a log-normal distribution. Since many variables in economics cannot take negative values and also do not have symmetric distributions, the log-normal distributions may be appropriate in some applications. | |

# CHAPTER 3
# METHODOLOGY

## Introduction

The sources of farm risks, farmer's perceptions and management responses to risk and uncertainty are ascertained through a survey of randomly selected farmers. The results of the farm risk survey are also used to determine important socioeconomic characteristics that affect the perception of the relative importance of risks and influence the use of risk-management responses.

The second part of the study involves the construction of an income simulation model of a typical middle-sized, mixed crop farm in North Florida. The income model is used to establish the cumulative probability distribution of income for various risk-management scenarios or farm plans. Application of stochastic dominance techniques is done to evaluate risk-efficient farm plans for different groups of farmers classified by their risk attitudes. Sensitivity analysis is performed by varying certain parameters in the income model.

## Survey Sampling and Administration Procedures

A survey to elicit farmers' perceptions and responses toward risk and uncertainty was conducted in Jackson County, North Florida, and

Henry County, South Alabama. The two counties are separated by only 25 miles and farming conditions in the two areas are nearly identical.

In July 1983, a questionnaire was developed by the author with the help of several members of the Department of Food and Resource Economics, University of Florida, Gainesville, Florida. The questionnaire was pretested on four farmers in Jackson County, North Florida, to aid in the improvement of the questionnaire. A similar questionnaire was developed later by the Southern Regional Research Project S-180 and some improvements in the questionnaire were made by comparing the survey questionnaire with the S-180 questionnaire.

The final survey questionnaire consists of several parts (see Appendix A). The first part asks general information about the farm. The farmers are also asked to define risk. The second part identifies and briefly illustrates various sources of risk in crop and livestock production, respectively. Twenty sources of risk in crop production and 18 sources in livestock production are identified. The farmers are asked to indicate the relative importance of each source of risk using 0 (does not apply) or 1 (not important) to 5 (extremely important). Immediately after ranking each source of risk, the farmers are asked what if any management responses they use to combat that particular risk.

Several suggested management responses to risk are listed and briefly described in the third part of the questionnaire. The farmers are then asked to indicate the importance of each management response by a ranking scale with 0 (meaning does not apply) or 1 (not important) through 5 (extremely important). They are also asked whether they use the specific management response or not. In fourth part of the questionnaire, the farmers are asked to list information needs for them to make farm decisions to deal with risk. The last part of the questionnaire contains information on the socioeconomic characteristics of farmers such as age, experience in farming, race or ethnic group, net worth and taxable farm income.

The final survey involved interviewing random samples of 25 farmers in each of the two counties. The sample was selected from a list of approximately 1,000 farmers classified as farmers by the county extension offices and the offices of the Agricultural Stabilization and Conservation Service. Random number generators were used to randomly select the sample farmers from the list. This technique has the advantage that the probability that a particular "category" of farmers will be sampled is equal to the population frequency. Conversely, the disadvantage is that relatively few observations are obtained for certain categories.

The North Florida survey was carried out by the author and several staff members of the Department of Food and Resource Economics, University of Florida, Gainesville, Florida. The South Alabama survey was undertaken by staff members from the Department of Agricultural Economics, Auburn University, Auburn, Alabama. The survey took place from September 1983 to about January 1984. From January 1984 to April 1984, cross-checking and editing of the questionnaire were done, sometimes involving interviewing some of the farmers again to gather more information. The data from both states were pooled for analysis. The analysis of the survey data was done from May to August 1984. Two out of the 25 farmers from the Alabama survey did not supply enough information and were deleted from the analysis.

The hypotheses tested in the survey are

(a) that farmers perceive various sources of risk in crop and livestock production in a hierarchy of importance;

(b) that farmers' perceptions of the relative importance of alternative sources of risk in crop and livestock production depend on certain socioeconomic characteristics such as experience in farming, educational level, size of farm, leverage ratio and the major crop grown; and

(c) that the use of risk-management responses by farmers depends on certain socioeconomic characteristics such as experience in farming, educational level, leverage ratio, major crop grown and size of farm.

The first hypothesis is tested by calculating the means and standard deviations of the rankings of the sources of risks by the farmers. The second hypothesis is tested by using chi-square tests between the various sources of risks and the socioeconomic characteristics. The third hypothesis is evaluated by the use of logistic regression techniques available through the SAS Funcat logistic regression test (SAS, 1982, pp. 257-285). Another logistic regression test is available as LOGIST test (SAS Institute, Inc., 1983, pp. 181-202) but is not supported by the SAS Institute so the Funcat logistic regression technique is chosen for this analysis. The theory of the logistic regression technique is described in Chapter 2 while the results from the logistic regression analysis are presented in Chapter 4.

## Procedures and Methods Involved in the Stochastic Modeling Analysis of Risk-Management Scenarios for the Typical Farm in North Florida

As a first step in the stochastic modeling of various risk-management scenarios, an income simulation model which incorporates output price risk and yield risk is constructed for a typical mixed crop farm in North Florida.

The typical mixed crop farm used in the modeling is obtained from the area extension office of Jackson County, North Florida. The farm produces four crops--corn, peanuts, soybeans and winter wheat--covering 55, 30, 100 and 50 acres, respectively, with a total size of 235 acres. The winter wheat is assumed to be double-cropped following soybeans. Production of the crops is based on conventional tillage on class one land. Class one land is defined as land with 0-2% slope. The model farm can be varied with respect to the type of soil, amounts of irrigation water applied during the season, the expected yields and the marketing technique used for the crops. All other agronomic and management conditions are assumed to be non-constraining and kept at normal operational levels. The planting and harvesting dates of the four crops used in the model are listed in Table 3-1. The planting and harvesting dates are assumed to cover a period of two weeks and they are chosen as the mid-point interval time period from the time periods given by the extension office, buying agencies and others. The farmer in the model, therefore, is assumed to make certain marketing and planting decisions within the two-week interval.

Table 3-1. Planting and Harvesting Dates for the Four Crops in North Florida

| Crop | Planting Date | Harvesting Date |
|---|---|---|
| Corn | March 8-22 | August 1-15 |
| Peanuts | April 15-29 | September 1-15 |
| Soybeans | May 22-June 5 | November 1-15 |
| Winter Wheat | November 15-30 | May 16-31 |

## The Base Income Simulation Model

The base income simulation model derives the income of the typical farm using 17 years of simulated yields of the four crops reflecting different weather years covering the period from 1955 to 1971. The output prices used in the model are historical prices from 1970 to 1984. This period reflects the new risky pricing environment. The period before 1970 is generally regarded as a fairly stable period (Brooke, 1978).

The model is implemented as a Fortran computer program (Appendix H). It calculates the net income distribution of the farm for the 16 risk-management scenarios or farm plans listed in Table 3-2. In simulating the yields of the crops, all the four crops are simulated over the same 17 years of weather data. The yields for a given year are jointly selected at random from the 17 observations. The choice of net output prices (output prices minus marketing transaction costs) is also done randomly. The model randomly selects the net output prices for all the crops jointly for the given year to account for any interdependence between the prices.

The correlation between the output prices and yields is assumed to be low for the typical farm and hence gross revenues of each risk-management scenario or farm plan are calculated as the product of the randomly selected yields and the randomly selected net output prices. In the model, 1984 is assumed to be the reference year for all other prices and costs. The total irrigation costs are calculated as the product of the amounts of irrigation water used to generate the simulated yields and the 1984 unit costs of irrigation water. The sum

Table 3-2. Listing of the Risk-Management Scenarios Modeled in the Income Simulation Model (Base Model)

| Scenario Number | Description of Risk-Management Scenario |
|---|---|
| 1 | Production condition--crops are grown on sands soils and irrigated. Marketing of crops is through cash sales at harvest time only. |
| 2 | Production condition--crops are grown on sandy-loam soils and irrigated. Marketing of crops is through cash sales at harvest time only. |
| 3 | Production condition--crops are grown on sands soils and not irrigated. Marketing of crops is through cash sales at harvest time only. |
| 4 | Production condition--crops are grown on sandy-loam soils and not irrigated. Marketing of crops is through cash sales at harvest time only. |
| 5 | Production condition--crops are grown on sands soils with irrigation. Marketing is carried out as a mix of cash sales at harvest time and forward contracting. About 50 percent of the 17 years average yields of the four crops are forward contracted. |
| 6 | Production condition--crops are grown on sandy-loam soils with irrigation. Marketing is carried out as a mix of cash sales at harvest time and forward contracting. About 50 percent of the 17 years average yields of the four crops are forward contracted. |
| 7 | Production condition--crops are grown on sands soils without irrigation. Marketing of the crops is done as a mix of cash sales at harvest time and forward contracting as in scenarios 5 and 6. |

Table 3-2. Continued

| Scenario Number | Description of Risk-Management Scenario |
|---|---|
| 8 | Production condition--crops are grown on sandy-loam soils without irrigation. Marketing of the crops is done as a mix of cash sales at harvest time and forward contracting as in scenarios 5 and 6. |
| 9 | Production condition--crops are grown on sands soils with irrigation. Marketing of the crops is carried out as a mix of cash sales at harvest time and futures hedging. Fifty percent of the average 17 year yields of the crops--soybeans and corn--or to the nearest thousand of bushels are hedged. The rest of the crops are sold for cash at harvest time. |
| 10 | Production condition--crops are grown on sandy-loam soils with irrigation. Marketing of the crops is done as a mix of cash sales at harvest time and hedging, the same as in scenario 9. |
| 11 | Production condition--crops are grown on sands soils without irrigation. Marketing of the crops is done as a mix of cash sales at harvest time and hedging, the same as in scenario 9. |
| 12 | Production condition--crops are grown on sandy-loam soils without irrigation. Marketing of the crops is done as a mix of cash sales at harvest time and hedging, the same as in scenario 9. |
| 13 | Production condition--crops are grown on sands soil with irrigation. Marketing of crops is done as a mix of cash sales at harvest time and futures put options. Fifty percent of the 17 years average yields of corn and soybeans or to the nearest thousands of bushels are sold to futures put options. The rest of the crop are sold for cash at harvest time. |

Table 3-2. Continued

| Scenario Number | Description of Risk-Management Scenario |
|---|---|
| 14 | Production condition--crops are grown on sandy-loam soil with irrigation. Marketing of crops is done as a mix of cash sales at harvest time and futures put options as in scenario 13. |
| 15 | Production condition--crops are grown on sands soils without irrigation. Marketing of crops is done as a mix of cash sales at harvest time and futures put options, as in scenario 13. |
| 16 | Production condition--crops are grown on sandy-loam soil without irrigation. Marketing of crops is done as a mix of cash sales at harvest time and futures put options, as in scenario 13. |

of the total irrigation costs and the total costs of dryland production for 1984 constitutes the total costs of irrigated production. The total costs of production are then subtracted from the gross revenues resulting in the net revenues per acre of each of the crop enterprises. The total net income for each crop enterprise is derived as the net revenues per acre multiplied by the number of acres devoted to the crop in the model farm. The total net income of the farm then becomes the sum of the net incomes from each of the four crop enterprises. The total net income for the farm is replicated 500 times in order to derive the income distribution and the creation of cumulative probability distribution of income. The replications allow for the random selections from the 17 "production" years and 15 "price" years or a total of 255 combinations of the sources of risk in the model. Appendix B lists the steps involved in building the income simulation model in a diagrammatic form.

Four production conditions and four marketing alternatives are used to model the 16 risk-management scenarios generated by the model which are listed in Table 3-2.

The production conditions are as follows:

(a) production of the crops on sands soils with irrigation;

(b) production of the crops on sandy-loam soils with irrigation;

(c) production of the crops on sands soils without irrigation; and

(d) production of the crops on sandy-loam soils without irrigation.

In the model, all the corn, peanuts and soybeans are irrigated for production conditions (a) and (b). The winter wheat crop is not irrigated at all under any condition because the common wheat varieties grown in Florida are drought-resistant and farmers rarely use irrigation. A center-pivot irrigation system is assumed.

The two soil types are sands and sandy-loam soils. The sands soil type consists of 80 percent sand, 12 percent silt and 8 percent clay particles and holds 2.7 inches of available water in the top 5 feet of soil (considered the rooting depth of the soil). The sandy-loam soil consists of 65 percent sand, 15 percent clay particles, 20 percent silt and holds 4.2 inches of available water in the top 5 feet of soil. These two soil types in the North Florida account for over 50 percent of all the soil types in the area and represent the dominant soil types used in crop production.

Irrigation scheduling in the model varies according to the crop and the soil type and is close to what is practised by many farmers in the area. For soybeans, for both sands and sandy-loam soils, irrigation is started when the available soil moisture is at 70 percent of the field capacity. Then 0.39 inch of water is applied. For corn grown on sands soils, irrigation is started anytime the available soil moisture reaches 1.7 inches. Then 3/4 inch of water is applied by irrigation. Irrigation is started when the available soil moisture reaches 2.7 inches and 1 inch of water is added for corn grown on sandy-loam soils. Peanuts grown on sands soils are irrigated when the available soil moisture reaches 1.7 inches and 3/4 inch of water is applied. Peanuts grown on sandy-loam soils are irrigated when the available soil moisture reaches 2.5 inches and then 1 inch of water is applied.

## Modeling the marketing strategies

The marketing strategies modeled are listed as follows:

(a) cash sales of the crop at harvest time;
(b) forward contracting at planting time;
(c) hedging of the crops at planting time; and
(d) selling the crops through futures options at planting time.

The key assumption used in modeling the net price per unit of crop sold under any of the above marketing strategies is that the farmer knows the planting time prices but does not know the actual harvest time prices. Many forces cause prices to fluctuate between the planting time and the harvest time in any given production year. These forces are linked to supply and demand interactions locally and to national and international markets. The change in a given price of a crop from planting time to harvest time in any production year is regarded as a random event that can take on different possible values. The historical prices from 1970 to 1984 are used to derive this random price variable. The change in both cash and futures prices from planting time to harvest time for the crops is highly variable as measured by the coefficient of variation (see Appendices D and E). The high variability of this variable emphasizes its random nature. The specific details used to model the different marketing strategies and hence calculate the net output prices are discussed below.

The use of the change in prices between the planting time to the harvest time within each year to model the expected net prices of the crops seems to be supported by the recent work of Musser et al. (1984). They estimate that the annual price trends associated with historical inflation from 1974 to 1982 show annual rate of increase of zero percent for corn, soybeans and wheat during the period. Hence it is the within-the-year changes in prices that should be considered the important source of price risk for the farmer for short-term planning purposes.

Cash sales of the crops at harvest times

This marketing strategy is modeled using the actual average prices of the four crops at planting times. The changes in the prices of the four crops from planting time to harvest time each year over the period 1970 to 1984 are considered possible sample values for the random variable. Expected harvest time of the crop for 1984 conditions (the reference year) is derived as follows:

$$ECP(L) = CPP(L) + CICP(NUM,L)$$

where ECP(L) is the expected harvest time price for crop L in 1984, where L = 1, 2, 3, 4 referring to the crops corn, peanuts, soybeans and winter wheat, respectively; CPP(L) is the actual average planting time price for crop L in 1984, the reference year of the model, and CICP(NUM,L) is the randomly selected change in price between planting time and harvest time.

The average planting and harvest time prices for the four crops from 1970 to 1984 are used for this analysis. For peanuts, since the farmer is assumed to have an acreage allotment with the price guaranteed by the federal government, the price used is the fixed government guaranteed price in 1984.

### Forward contracting

This strategy is modeled for all four crops--corn, peanuts, soybeans and winter wheat. Once again for peanuts, the forward contract price is equivalent to the government guaranteed price since the crop price is guaranteed at planting time for those farmers with an allotment acreage. The farm in the model is assumed to have an allotment acreage of 30 acres.

Average contract prices at planting time in 1984 paid to the farmers in North Florida are used in the modeling of the prices and hence the net income. It is also assumed that for all the risk-management scenarios or farm plans that involve forward contracting, only 50 percent of the 17 years average yields are forward contracted. The remaining 50 percent are sold for cash at harvest time and the procedures outlined in the previous section are used to generate the expected harvest time cash prices.

### Hedging

The hedging strategy is modeled only for corn and soybeans to approximate the behavior of the farmers in the North Florida area since these are two main crops hedged. Fifty percent of the 17 years average yields rounded off to the nearest thousand of bushels of the two crops are assumed to be hedged. For all the risk-management scenarios or farm plans involving hedging, the remainder of the two crops (corn and soybeans) plus all the quantities of the other two crops produced (peanuts and winter wheat) are sold for cash at harvest time.

The actual hedging net price of a crop (AHNP(L)) for 1984 conditions is calculated as follows:

$$\mathrm{AHNP(L)} = \mathrm{FUPP(L)} - \mathrm{BASIS(NUM,L)} - \mathrm{COMM(L)}$$

where FUPP(L) is the average futures price at planting time in 1984 for the two crops, corn and soybeans; BASIS(NUM,L) is the randomly selected basis for the crop L in one of the 15 sample price years (1970-1984) and COMM(L) is the commission or the brokerage fees per unit of the crop in 1984.

The actual hedging net price, therefore, is based on the assumption that the farmer at planting time is aware of the futures price but that the actual hedging net price is not known because of variation in the basis.

### Futures options

The futures options marketing strategy was introduced in early November 1984 at the Chicago Board of Trade and is one of the newest marketing tools available to farmers to use to reduce price risk. Recent literature explains the working of the futures options scheme for farmers (Schmiesing, 1984; Catania et al., 1984; Dalton and Bailey, 1984).

A futures option conveys the right but not the obligation to buy or sell a given amount of a commodity at a predetermined price on or before a specific date. Two types of commodity options exist. A call option refers to the right to buy at a predetermined or strike price while a put option refers to the right to sell at a predetermined price. Since this study is concerned with product marketing, only put options are considered.

For the farmer to purchase a futures put option, he must pay an option premium to the seller of the option. The size of the option premium is determined theoretically by the relationship between the strike price and the futures market price, the number of days before the expiration of the option, historical price volatility of the futures contract and the prevailing interest rates. The size of the option premium increases with increasing difference between the strike price and the futures price and the longer the number of days before the option expires. It also increases with higher volatility of the futures market and higher interest rates. The size of the option premium plus the farmer's expectations for future price changes are key factors determining whether the farmer should buy an option or not.

In this model, the farmer sells about 50 percent of the 17 years average yields of his corn and soybeans rounded off to the nearest thousand of bushels in the futures options market. The farmer decides on a strike price and pays the corresponding premium. The initial strike price is set at the average planting time futures price for both crops. The risky nature of the futures put options decision rests on the fact that the farmer does not know what the futures price will be at the expiration time. It is also partly due to the variability in the basis. These two factors determine the size of his actual net options price for the crops.

The futures option has to be delivered or exercised about one month before the futures delivery month. In this study, the farmer decides whether to exercise the futures or not one month before the harvest date since the farmer is assumed to purchase the futures contract nearest the harvest time month. If the futures price at expiration time is greater than the strike price, then the farmer will not exercise the option and will let it expire worthless. He then gets the prevailing futures price less the basis less the premium and less the commission and brokerage fees. If the futures price at the expiration time is less than the strike price, then the farmer will exercise the put options and the net price becomes the strike price less the premium less the basis less the brokerage or commission fees.

Hence the actual net options price (AONP(L)) is determined as follows:

(a) DO NOT EXERCISE THE FUTURES OPTIONS--If (FUPP(L) + CIFP(NUM,L)) $>$ STRKP(L) THEN AONP(L) = (FUPP(L) + CIFP(NUM,L)) - PREM(L) - BASIS(NUM,L) - COMM(L).

(b) EXERCISE THE FUTURES OPTION--If (FUPP(L) + CIFP(NUM,L)) $\leq$ STRKP(L) then AONP(L) = STRKP(L) - PREM(L) - BASIS(NUM,L) - COMM(L).

where FUPP(L) is the futures price at planting time for the crop L; CIFP(NUM,L) is the randomly selected change in the futures price from planting time to the expiration date of the options contract; STRKP(L) is the strike or the predetermined price chosen by the farmer for crop L; PREM(L) is the premium charged for the corresponding strike price for crop L; COMM(L) is the commission or the brokerage fees for crop L and BASIS(NUM,L) is the randomly selected basis for crop L among the 15 possible values (1970-1984).

## Sources of Data for the Income Simulation Model

The simulated yields of the four crops are based on several crop simulation models available in the Institute of Food and Agricultural Sciences, University of Florida. The yields for corn and peanuts are derived from the work of Duncan (1976a, b). The soybean growth simulation model was developed by Wilkerson et al. (1982). The winter wheat simulation model is developed for this study.

All these crop simulation models are used to estimate the yields of the crops and irrigation water use of the crops using 17 years of historical weather data (1955 to 1971) from the Chipley weather station in North Florida. These crop models are mathematical representations of the biological and physiological processes determining the growth of the crops. The forms of the models are derived from the theories of the underlying biological processes and the coefficients are empirically determined. More importantly, the models have all been validated to correspond closely to actual yields obtained under North Florida conditions. Appendix C presents the simulated yields and irrigation water use for corn, peanuts, soybeans and winter wheat for the 17 years used as data in the income simulation model.

Cash prices from 1970 to 1984 for corn, peanuts, soybeans and winter wheat used in the analysis are obtained from several sources. Prices from 1979 to 1984 for corn and soybeans and the 1984 prices for winter wheat and peanuts are obtained from the Goldkist district office in Campbellton, North Florida, and the Agricultural Research Center of IFAS in Marianna, North Florida. Prices from 1970 to 1978 for corn and soybeans could not be obtained for North Florida and hence the most reliable prices from the nearest state, Georgia, are used as approximate prices. The Georgia prices are obtained from the Georgia Crop Reporting Service. Similarly, Georgia price data are used for winter wheat from 1969-70 to 1975-76 and for 1981-82. Average United States prices obtained from the United States Department of Agriculture are used for winter wheat from 1976-77 to 1980-81 and 1982-83 because there are no reliable available data from either Florida, Georgia or Alabama. The government guaranteed price for peanuts in Marianna, North Florida, is used for peanuts. The cash prices from 1970 to 1984 used as data in the income simulation model are reported in Appendix D.

Futures prices including the basis for corn and soybeans from 1970 to 1984 used as data in the hedging and the futures options marketing strategies are obtained from the Chicago Board of Trade. The basis defined as the futures price minus local cash price at harvest time is derived partly using the cash prices listed in Appendix D.

Commission and brokerage fees charged for using the appropriate futures market are obtained from several brokerage firms in Marianna, North Florida. The premiums used to calculate the actual net price for the corn and soybeans traded under the futures put options are derived using the Agnet Options Program written by Dr. Brian Schmiesing of South Dakota State University. The premiums generated by the program are theoretical premiums. These theoretical premiums are derived by using several inputs data--the interest rate, futures prices and the historical volatility of the futures prices. The interest rate is assumed to be 14 percent while the futures prices are obtained from various issues of the Wall Street Journal from November 1984 to February 1985. The historical volatility is based on futures prices changes from May 1984 (the planting time of soybeans) to the relevant date of analysis (i.e., December 1984 to February 1985) and is calculated by the Agnet Options Program. The premiums are derived for March, May, July and November 1985 soybeans futures contracts. Only soybeans are considered because of the very limited actual premiums data for corn making validation of the theoretical premiums for corn near impossible.

The theoretical premiums derived are validated by testing them with actual premiums obtained from the various issues of the Wall Street Journal from December 1984 to February 1985. A simple linear regression analysis is performed between the actual premiums and the theoretical premiums. A perfect relationship would provide a line passing through the origin with a slope of one, that is a 1:1 correspondence and also a correlation coefficient between the two variables of exactly one. The test, therefore, is to determine whether the intercept is significantly different from zero and the slope is significantly different form unity.

The simple linear regression between actual and theoretical premiums derived is

$$\begin{aligned} X_2 &= \underset{(0.2466)}{-0.0347} + \underset{(0.0001)}{0.969}\, X_1 \\ R^2 &= 0.899;\ \text{standard error of the estimate of the slope} = 0.0593 \end{aligned}$$

Where $X_2$ is the actual premium; $X_1$ is the theoretical premium; the figures in parentheses are the levels of significance of the parameters estimates based on the null hypothesis that they are not statistically different from zero. The $R^2$ is the coefficient of determination meaning that about 90 percent of the variation in the actual premium is explained by the theoretical premium (or the Agnet options model).

The above equation indicates that the intercept is not statistically different from zero. However, the slope is statistically different from zero but not different from unity.[1] These results, therefore, emphasize a 1:1 proportional relationship between the actual and the theoretical premiums. The evidence of a 1:1 proportional relationship is strengthened by the fact that the correlation coefficient between the theoretical and the actual premiums is 0.948 which can be considered high and close to unity. Personal communication with Dr. Schmiesing in January 1985 indicated that the options program has been working well, partly because many traders have also been using the program. The futures prices from 1970 to 1984 used for the analysis are listed in Appendix E.

The estimated dryland costs of producing corn, peanuts, soybeans and winter wheat for 1984 are obtained from the Agricultural Research Center of IFAS in Marianna, North Florida, and are reported in Appendix F. The items used to estimate the unit cost of irrigation water are obtained from the same source and are listed in Appendix G. These data items are used as inputs in an irrigation cost generator model developed by d'Almada et al. (1985) for North Florida conditions to estimate the fixed and variable costs of irrigation. The d'Almada

---

[1] The t-test to determine whether the slope is statistically different from unity is derived as follows:

$$\frac{0.969 - 1.0}{0.593} = 0.518$$

With 30 degrees of freedom, this value is not significant at any acceptable level.

irrigation cost generator model has been validated and found to be reliable for North Florida conditions.

## The Stochastic Dominance Analysis

The cumulative probability distributions of income for the different farm plans are subjected to the stochastic dominance with respect to a function methodology to determine risk-efficient farm plans based on the risk attitudes of the different groups of farmers. The theory and limitations of the stochastic dominance with respect to a function methodology are described in Chapter 2. The stochastic dominance with respect to a function methodology compares cumulative probability distributions of farms plans for different groups of farmers who are classified by their risk attitudes defined by the lower and upper bounds of their risk-aversion coefficient. Appendix I presents the stochastic dominance with respect to a function computer program written in Fortran language by Meyer in 1977.

The key input needed to use the stochastic dominance with respect to a function program is the absolute risk-aversion coefficient intervals of the target farmers, in this case North Florida mixed crop farmers (refer to Chapter 2). Since no empirical work has been done to estimate farmers' utility functions and the absolute risk-aversion coefficients in Florida, secondary works from other parts of the United States are used to establish appropriate absolute risk-aversion coefficients intervals (Young et al., 1979; Kramer and Pope, 1981; Wilson, 1982; King and Oamek, 1983; Wilson and Eidman, 1983; Rister et al., 1984; Love and Robison, 1984). The absolute risk-aversion coefficient intervals chosen are those that are common to all the studies.

A special interval of the absolute risk-aversion coefficient is also devised to correspond to the risk-neutral farmers. Risk-neutral farmers maximize expected profits and their behavior is consistent with results established from the neo-classical theory of the farm-firm. This interval has both the upper and lower bound of the absolute risk-aversion coefficient set equal to zero. Table 3-3 presents the various groups of farmers defined by their lower and upper bounds of the absolute risk-aversion coefficient. Figure 3-1 summarizes the steps involved in determining the risk-efficient set of farm plans involved in this study.

## The Hypotheses Tested

The hypotheses tested for this part of the study are

(a) that the choice of the sample size or the number of replications of income used to estimate the cumulative probability distributions does not affect the risk-efficient set of farm plans;

(b) that farmers behave differently in their choice of risk-management scenarios or farm plans (involving a mix of production and marketing strategies) according to their risk attitudes;

(c) the use of the futures market by the farmer can affect farm incomes and the choice of farm plans according to the risk attitude of the farmer; and

(d) that reducing the average acreage allotment devoted to peanuts and replacing it with equal acreage of corn, wheat or soybeans affects farm incomes.

Table 3-3. Definition of Groups of Farmers According to the Lower and Upper Bound of Their Absolute Risk-Aversion Coefficient[a]

| Type of Group | Lower Bound of Absolute Risk-Aversion Coefficient | Upper Bound of Absolute Risk-Aversion Coefficient |
|---|---|---|
| Moderate Risk Loving | -0.00050 | -0.00001 |
| Low Risk Loving | -0.00001 | 0.00000 |
| Risk Neutral (Maximizers of expected profits) | 0.00000 | 0.00000 |
| Very Low Risk Averse | 0.00000 | 0.00001 |
| Low Risk Averse | 0.00001 | 0.00003 |
| Moderate Risk Averse I | 0.00003 | 0.00005 |
| Moderate Risk Averse II | 0.00005 | 0.00007 |
| Moderate Risk Averse III | 0.00007 | 0.00010 |
| High Risk Averse | 0.00010 | 0.00050 |
| Very High Risk Averse | 0.00050 | 0.00100 |
| Second Degree Stochastic Dominance | 0.00000 | 0.00100 |
| First Degree Stochastic Dominance | -0.00100 | 0.00100 |

---

[a] Absolute risk aversion coefficient is defined as $\frac{-U''(Y)}{U'(Y)}$ where U"(Y) and U'(Y) are the second and first derivatives of the utility function of income (U(Y)).

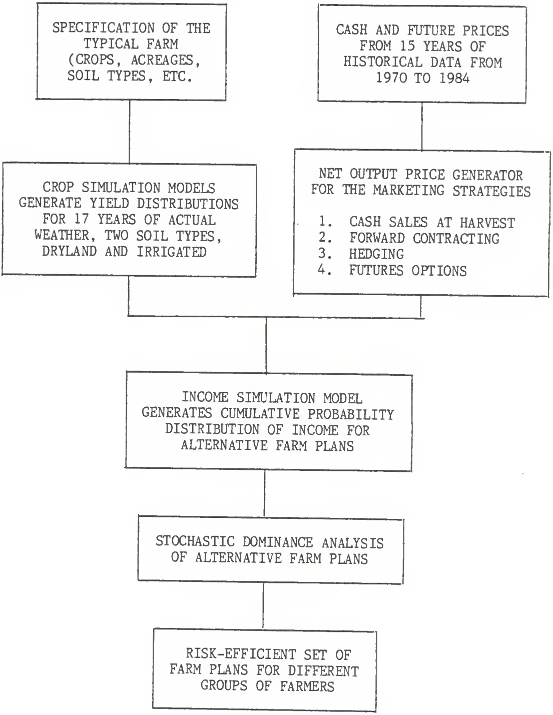

SPECIFICATION OF THE TYPICAL FARM (CROPS, ACREAGES, SOIL TYPES, ETC.
CASH AND FUTURE PRICES FROM 15 YEARS OF HISTORICAL DATA FROM 1970 TO 1984
CROP SIMULATION MODELS GENERATE YIELD DISTRIBUTIONS FOR 17 YEARS OF ACTUAL WEATHER, TWO SOIL TYPES, DRYLAND AND IRRIGATED
NET OUTPUT PRICE GENERATOR FOR THE MARKETING STRATEGIES
1. CASH SALES AT HARVEST
2. FORWARD CONTRACTING
3. HEDGING
4. FUTURES OPTIONS
INCOME SIMULATION MODEL GENERATES CUMULATIVE PROBABILITY DISTRIBUTION OF INCOME FOR ALTERNATIVE FARM PLANS
STOCHASTIC DOMINANCE ANALYSIS OF ALTERNATIVE FARM PLANS
RISK-EFFICIENT SET OF FARM PLANS FOR DIFFERENT GROUPS OF FARMERS

Figure 3-1. Flow Chart of Steps Involved in Determining the Risk-Efficient Set of Farm Plans

The hypotheses are evaluated using sensitivity analysis involving the income simulation model by varying the values of the variables in the model. For the first hypothesis, the sample size is varied from 50, 100, 125, 150, 200, 300, up to 500. The third hypothesis is tested by varying the participation level or the amounts of the crops traded in the futures market. Specifically for the futures options, the strike prices and their corresponding premiums are varied several times below and above the planting time futures price. The fourth hypothesis is evaluated by replacing 15 acres devoted to peanuts with either corn, soybeans or winter wheat and then deriving the cumulative probability distributions of income for the different farm plans. The second hypothesis is evaluated by running the base income simulation model and the stochastic dominance analysis. The stochastic modeling analysis (of the different risk-management scenarios) portion of the entire study was done between August 1984 and July 1985.

# CHAPTER 4
# RESULTS OF THE FARM SURVEY RISK ANALYSIS

## Farmers' Definitions of Risk

All the sample farmers agree that there is much risk in farming. Most of their definitions of risk essentially focus on the potential of negative or adverse outcomes or the probability of not achieving specified income goals. However, a couple of farmers express their definitions as relating to the potential for gains involved in making decisions. Some other definitions of risk seem to move away from outcomes such as incomes and rather place stress on the possibility of loss of assets and other inputs. This observation might indicate that farmers' perceptions of risk involve both the inputs and outputs in the production process.

## Information Needs for Dealing with Farm Risk

Farmers are asked to respond to a series of questions dealing with information and risk. The first question asks what the key farm decisions are. The most common response is what crops to plant and how much of each. For most farmers in the area, peanut acreage is fixed by their allotment given by the federal government. Peanuts incidentally are the major crop produced by the farmers in the area. After peanuts, however, there are few, if any, clearly dominating choices. Weather, pests and price uncertainty combine to make this a difficult decision.

Other crops produced include corn, soybeans, winter wheat, sorghum and watermelons.

The second most common response to the key farm decisions made by farmers is when to plant. Weather and pests uncertainty are the major risk factors that complicate this decision. The long growing season and alternative varieties allow a number of crops to be planted over a relatively wide range of dates. The only other responses mentioned by more than three farmers are the amount of money to be borrowed and the time to sell the crops.

Farmers are then asked the types of information that are most useful in making these key decisions. The most important response is demand and price outlook. It is clear from the farmers' response that outlook information is critical in making decisions on what and how much to plant as well as deciding on when to sell. Extension production information is the second most common type of information used. This type of information is most useful in dealing with the question of the time of planting as it relates to controlling pests. Only four of the responses to this question mention records or cost of production. It seems, therefore, that the majority of farmers view records as an income tax requirement, but not as a management tool. This would appear to be an opportunity for extension education programs, perhaps harnessing the power of microcomputers to make records keeping more useful to farmers.

The third question in the series is designed to determine if farmers practise "risk balancing." The question asked read, "If you take an action which increases risk/uncertainty in one aspect of your operation, do you try to offset or balance this with other actions in another part of the business?" For example, if a farmer decides to grow watermelons (a relatively risky crop) this additional risk might be offset by irrigating and forward contracting his corn and soybeans. This question is probably the most misunderstood question in the survey. However, it is quite clear from the responses that few, if any, of the farmers have thought about or deliberately practised risk balancing. Only two farmers respond that they do, although they have not thought about it in those terms.

The final question relates to whether the farmers' responses to risk/variability have resulted from or been influenced by other people or institutions (e.g., lenders). The county extension agent is the most frequently mentioned person. This response illustrates the impact that a good agent may have in an area. Neighbors and parents finish second and third, respectively, in the list of most influential people.

## Socioeconomic Characteristics of the Farmers

Of the 48 farmers interviewed, 25 are from Jackson County, Florida, and the remaining 23 from Henry County, Alabama. Forty-one of the farmers (20 from Florida and 21 from Alabama) grow both crops and livestock, five farmers (three from Florida and two from Alabama) produce only crops while two farmers (both from Florida) produce only livestock.

Forty of the sample farmers are white and the remaining eight black. The educational statues of the sample farmers is listed in Table 4-1. Twenty-five percent of the farmers are classified as having received some post-high school education. They have either attended a two-year college or vocational school. The average farming experience

Table 4-1. Educational Level of Sample Farmers

| Level of Education Attained | Number | Relative Frequency |
|---|---|---|
| Some high school | 14 | 29.2 |
| High school graduate | 11 | 22.9 |
| Some post-high school education | 12 | 25.0 |
| Four year college graduate or higher | 11 | 22.0 |
| Total | 48 | 100.0 |

of the farmers is 26.5 years with a standard deviation of 14.1. The number of farmers grouped according to the length of farming experience is reported in Table 4-2.

Forty-six of the 48 farmers are currently married and the average number of dependents is 2.3. The average size of farm currently under crops and harvestable forage is 312 acres and the average acreage of pasture and range is 172 acres. The number of farmers classified according to the size of farm currently under crops and harvestable forage is presented in Table 4-3. The smallest size of farm is 30 acres with the largest being 1075 acres. Thirty-two or exactly two-thirds of the farmers list peanuts as their dominant crop. Twenty-eight out of the 48 farms are operated as individual proprietorships while 18 out of the remaining 20 are operated under family partnership. The other two are managed as corporations.

Based on their 1982 taxable farm income, 14.3 percent of the sample farmers have negative incomes (Table 4-4). Six or 14.3 percent of the farmers have incomes of $50,000 or more while 62 percent of the farmers have 1982 farm incomes of less than $20,000.

The farms are also classified according to their leverage ratio (Table 4-5). Leverage, defined as total farm debts divided by total farm assets, is a commonly used measure of financial solvency. A leverage ratio of 0.50 or greater is normally regarded as unstable and a ratio of 1.0 means that the farm is bankrupt. Eight of the farmers have leverage ratios of greater than 0.50 (actually ranging from 0.52 to 0.84) while seven farmers have a zero leverage ratio indicating they have no borrowed funds. Table 4-6 presents a breakdown by size of farm, of several socioeconomic characteristics of the farmers.

Table 4-2. Classification of Sample Farmers by Length of Experience in Farming

| Number of Years | Number of Farmers | Relative Frequency |
|---|---|---|
| Less than 10 years | 7 | 14.6 |
| 10–24 | 17 | 35.4 |
| 25–39 | 11 | 22.9 |
| 40 or greater | 13 | 27.1 |
| Total | 48 | 100.0 |

Table 4-3. Classification of Sample Farmers According to Size of Farm Presently under Crops and Harvestable Forage

| Size in Acres | Number of Farmers | Relative Frequency |
|---|---|---|
| Less than 150 acres | 15 | 31.3 |
| 150-500 | 23 | 47.9 |
| Greater than 500 | 10 | 20.8 |
| Total | 48 | 100.0 |

Table 4-4. Classification of Sample Farmers According to Their 1982 Taxable Farm Income

| Size in Dollars | Absolute Number of Farmers | Relative Frequency |
|---|---|---|
| Negative | 6 | 14.3 |
| $0-$9,999 | 12 | 28.6 |
| $10,000-$19,999 | 8 | 19.0 |
| $20,000-$49,999 | 10 | 23.8 |
| $50,000-$99,999 | 4 | 9.5 |
| $100,000 and over | 2 | 4.7 |
| Subtotal | 42 | 100.0 |
| Not reported | 6 | -0- |

Table 4-5. Classification of Sample Farmers According to the Leverage Ratio of Their Farms

| Leverage Ratio | Number of Farmers | Relative Frequency |
|---|---|---|
| Zero | 7 | 18.4 |
| 0.01-0.20 | 14 | 36.8 |
| 0.21-0.50 | 9 | 23.7 |
| 0.51-1.00 | 8 | 21.0 |
| Subtotal | 38 | 100.0 |
| Not reported | 10 | -0- |

Table 4-6. Socioeconomic Characteristics of the Sample Respondents by Size (Acreage) of Farms

| Item | Small < 150 Acres | Medium 150-500 Acres | Large > 500 Acres | Total |
|---|---|---|---|---|
| | ---------- Percent[a] | ---------- | ---------- | ---------- |
| 1. Financial Leverage Ratio[b] | | | | |
| zero | 5.3 (20.1) | 10.5 (20.0) | 2.6 (12.4) | 18.4 |
| 0.01-0.20 | 15.8 (60.1) | 18.4 (35.0) | 2.6 (12.4) | 36.8 |
| 0.21-0.50 | 2.6 (9.9) | 13.2 (25.0) | 7.9 (37.6) | 23.7 |
| 0.51-1.00 | 2.6 (9.9) | 10.5 (20.0) | 7.9 (37.6) | 21.1 |
| Total | 26.3 (100.0) | 52.6 (100.0) | 22.1 (100.0) | 100.0 |
| 2. Taxable Farm Income ($)[c] | | | | |
| Negative | 2.4 (9.1) | 9.5 (19.0) | 2.4 (10.1) | 14.3 |
| 0-9,999 | 14.3 (54.6) | 11.9 (23.8) | 2.4 (10.1) | 28.6 |
| 10,000-19,999 | 4.8 (18.3) | 11.9 (23.8) | 2.4 (10.1) | 19.1 |
| 20,000-49,999 | 4.8 (18.3) | 11.9 (23.8) | 7.1 (29.8) | 23.8 |
| 50,000-99,999 | 0.0 (0.0) | 2.4 (4.8) | 7.1 (29.8) | 9.5 |
| 100,000 or more | 0.0 (0.0) | 2.4 (4.8) | 2.4 (10.1) | 4.8 |
| Total | 26.2 (100.0) | 50.0 (100.0) | 23.8 (100.0) | 100.0 |

Table 4-6. Continued

| Item | Small<br>< 150<br>Acres | Medium<br>150-500<br>Acres | Large<br>> 500<br>Acres | Total |
|---|---|---|---|---|
| | Percent[a] | | | |
| 3. Years of Experience in Farming[d] | | | | |
| 0-9 | 2.1 (6.7) | 6.3 (13.2) | 6.3 (30.2) | 14.6 |
| 10-24 | 16.7 (53.4) | 16.7 (34.8) | 2.1 (10.1) | 35.4 |
| 25-39 | 4.2 (13.4) | 10.4 (21.6) | 8.3 (39.7) | 22.9 |
| 40 years or more | 8.3 (26.5) | 14.6 (30.4) | 4.2 (20.1) | 27.1 |
| Total | 31.3 (100.0) | 47.9 (100.0) | 20.8 (100.0) | 100.0 |
| 4. Education[d] | | | | |
| Some high school | 10.4 (33.2) | 16.7 (34.9) | 2.1 (10.1) | 29.2 |
| High school graduate | 4.2 (13.4) | 10.4 (21.7) | 8.3 (39.9) | 22.9 |
| Two year college/ vocational | 10.4 (33.2) | 12.5 (26.1) | 2.1 (10.1) | 25.0 |
| Four year college | 6.3 (20.1) | 8.3 (17.3) | 8.3 (39.9) | 22.9 |
| Total | 31.3 (100.0) | 47.9 (100.0) | 20.8 (100.0) | 100.0 |

Table 4-6. Continued

| Item | Small<br>< 150<br>Acres | Medium<br>150-500<br>Acres | Large<br>> 500<br>Acres | Total |
|---|---|---|---|---|
| | ------------ Percent[a] ------------ | | | |
| 5. Dominant Crop Grown[d] | | | | |
| Peanuts | 18.8 (60.1) | 37.5 (78.3) | 10.4 (50.0) | 66.7 |
| Any other crop | 12.5 (39.9) | 10.4 (21.7) | 10.4 (50.0) | 33.3 |
| Total | 31.3 (100.0) | 47.9 (100.0) | 20.8 (100.0) | 100.0 |

[a] Values in parenthesis are the percent within each size stratum.

[b] Based on 38 responses. Leverage ratio is defined as total debts divided by total assets.

[c] Based on 42 responses.

[d] Based on 48 responses.

Larger farms tend to be more highly leveraged. Three-fourths of the large farms have leverage ratios over 0.20 compared to 45 percent for medium and only about 20 percent for small farms (Table 4-6). Notice, also, that 30 percent of all large farms are managed by farmers with less than 10 years of farming experience compared to 13 percent and about 7 percent for medium and small farms, respectively. Similarly, 62 percent of the farmers with 40 years or more experience have leverage ratios of 0.20 or lower and none has a ratio greater than 0.50 (Table 4-7). These figures suggest that more experienced farmers are financially more conservative than their younger counterparts. One obvious explanation is the life cycle hypothesis which suggests that older farmers are likely to be as large as they desire and, therefore, will be less likely to have made recent large investments in fixed assets.

The data in Table 4-6 indicate that only 18 percent of the small farms report taxable incomes of $20,000 or larger, whereas 33 percent of the medium farms and 70 percent of the large farms report taxable incomes of $20,000 or over. As one would expect there seems to be a positive correlation between size of farm and income. Larger farms (which tend to be highly leveraged) obtained relatively higher incomes indicating that the higher incomes are obtained at the price of higher risk. It should also be noted that only 15.5 percent of farmers with 40 or more years experience have farms larger than 500 acres compared to 43.2 percent of farmers with less than 10 years experience. It appears, therefore, that more experienced (older) farmers tend to keep relatively smaller but lower leveraged farms and obtain lower but more stable incomes.

Table 4-7. Socioeconomic Characteristics of the Sample Respondents by the Financial Leverage Ratio of Their Farms[a]

| Item | Low (0.00-0.20) | Medium (0.21-0.50) | High (0.51-1.00) | Total |
|---|---|---|---|---|
| | ---------------------------- | Percent[b] | ---------------------------- | |
| 1. 1982 Taxable Farm Income ($) | | | | |
| Negative | 5.4 (9.5) | 5.4 (25.0) | 2.7 (12.5) | 13.5 |
| 0-9,999 | 24.3 (42.8) | 2.7 (12.5) | 5.4 (25.0) | 32.4 |
| 10,000-19,999 | 10.8 (19.0) | 2.7 (12.5) | 2.7 (12.5) | 16.2 |
| 20,000-49,999 | 10.8 (19.0) | 2.7 (12.5) | 10.8 (50.0) | 24.3 |
| 50,000-99,999 | 5.4 (9.5) | 2.7 (12.5) | 0.0 (0.0) | 8.1 |
| 100,000 or more | 0.0 (0.0) | 5.4 (25.0) | 0.0 (0.0) | 5.4 |
| Total | 56.8 (100.0) | 21.6 (100.0) | 21.6 (100.0) | 100.0 |
| 2. Years of Experience in Farming | | | | |
| 0-9 | 7.9 (14.3) | 2.6 (11.0) | 2.6 (12.3) | 13.2 |
| 10-24 | 26.3 (47.6) | 5.3 (22.4) | 10.5 (49.8) | 42.1 |
| 25-39 | 7.9 (14.3) | 7.9 (33.3) | 7.9 (37.9) | 23.7 |
| 40 years or more | 13.2 (23.9) | 7.9 (33.3) | 0.0 (0.0) | 21.1 |
| Total | 55.3 (100.0) | 23.7 (100.0) | 21.1 (100.0) | 100.0 |

Table 4-7. Continued

| Item | Low<br>(0.00-0.20) | | Medium<br>(0.21-0.50) | | High<br>(0.51-1.00) | | Total |
|---|---|---|---|---|---|---|---|
| | Percent[b] | | | | | | |
| 4. Education | | | | | | | |
| Some high school | 15.8 | (28.6) | 5.3 | (22.4) | 5.3 | (25.2) | 26.4 |
| High school graduate | 13.2 | (23.9) | 7.9 | (33.3) | 2.6 | (12.4) | 23.7 |
| Two year college/ vocational | 10.5 | (19.0) | 2.6 | (11.0) | 10.5 | (50.0) | 23.6 |
| Four year college | 15.8 | (28.5) | 7.9 | (33.3) | 2.6 | (12.4) | 26.3 |
| Total | 55.3 | (100.0) | 23.7 | (100.0) | 21.0 | (100.0) | 100.0 |
| 3. Dominant Crop Grown | | | | | | | |
| Peanuts | 36.8 | (66.5) | 15.8 | (66.7) | 13.2 | (62.6) | 65.8 |
| Any other crop | 18.4 | (33.4) | 7.8 | (33.3) | 7.9 | (37.4) | 34.2 |
| Total | 55.3 | (100.0) | 23.7 | (100.0) | 21.1 | (100.0) | 100.0 |

[a] Based on 38 responses.

[b] Values in parentheses are the percent within each leverage ratio stratum.

The figures from Table 4-6 and 4-7 indicate that there is no clear relationship between educational status of the farmer and either the size of the farm or the leverage ratio.

## Sources of Farm Risks

Over half of farmers' definitions of risk explicitly mention weather or pests. Not surprisingly then, production risks, specifically rainfall variability and pests (insects, weeds and diseases) are identified as the major sources of crop risk (Table 4-8). With respect to rainfall variability, irrigation is the most common management response. Other common management practices used to combat rainfall variability include minimum tillage, subsoiling and crop selection (wheat and grain sorghum).

Chemical control dominates management responses to pests. Chemicals are used to control weeds, insects, diseases and nematodes. Each of these pests is a major problem due to the warm, humid climate. Rotating grass crops between crops of soybeans or peanuts to control nematodes is the second most common practice. Other common management responses to production risk include using resistant varieties, scouting for insects and diseases, planting corn early to beat the insects and spraying and worming livestock routinely.

Market related risks are the second most important category of risk with variability in commodity prices leading in importance. Variability in the costs of operating inputs and in the cost of capital equipment are also considered an important source of risk (Table 4-8). Forward contracting is the most common management response to variability in commodity prices. Soybeans are the most

Table 4-8. Mean Importance Rankings and Standard Deviations of Sources of Risk and Variability in Crop Production

| No. | Source of Risk and Variability | Mean Ranking of Importance | Standard Deviation | Ranking Class |
|---|---|---|---|---|
| | | | | Extremely important |
| 1 | Rainfall variability | 4.70 | 0.59 | |
| 2 | Diseases and pests | 4.50 | 0.75 | |
| 3 | Commodity prices | 4.22 | 1.01 | |
| | | | | Very Important |
| 4 | Inflation | 3.60 | 1.64 | |
| 5 | Government commodity programs | 3.53 | 1.39 | |
| 6 | Costs of operating inputs | 3.50 | 1.17 | |
| 7 | Personal safety and health | 3.35 | 1.42 | |
| 8 | World economic situation | 3.16 | 1.36 | |
| 9 | Cost of capital equipment | 3.15 | 1.41 | |
| 10 | Cost of credit | 3.04 | 1.72 | |
| | | | | Moderately Important |
| 11 | Federal and State government laws | 2.96 | 1.69 | |
| 12 | Family plans | 2.51 | 1.59 | |
| 13 | Theft of farm equipment, etc. | 2.33 | 1.59 | |
| 14 | Hired labor | 2.24 | 1.79 | |
| 15 | Changes in technology | 2.22 | 1.59 | |
| 16 | Availability of loan funds | 2.06 | 1.55 | |
| 17 | Use of leverage | 2.00 | 1.55 | |
| 18 | Other climatic factors (wind, etc.) | 2.00 | 1.83 | |
| | | | | Not Important |
| 19 | Leasing | 1.67 | 1.03 | |
| 20 | Freezes | 0.91 | 1.09 | |

common commodity contracted. Other less common management responses are drying and storage and shopping around for the best price. Farmers for the most part feel that there is little they can do to combat variability in the costs of operating inputs or capital equipment. Most indicate that they shop around to take advantage of cash or quantity discounts on operating inputs. However, with the average farm size being 312 acres, bulk discounts are uncommon. In the case of capital equipment, most farmers indicate that they delay replacing equipment and concentrate on maintenance of existing machinery.

Since peanuts are the dominant cash crop in the area for farmers with an allotment, it is not surprising that government commodity programs are the fifth highest ranked source of risk. Farmers frequently mention uncertainty over the future of the peanuts program as a major risk factor. The future of payment in kind (PIK) or similar programs is another common concern.

Table 4-9 reports the results of the importance of the sources of risk in livestock production. Commodity prices rank first followed by weather variability and diseases and pests in exact reverse to the ranking of crop risks. In addition, the mean ranking of each source of risk in livestock is slightly lower than the ranking of the same source of risk in crop production.

## Management Responses to Risk

In addition to ranking the importance of various sources of risk and indicating how they attempt to manage those risks, farmers are asked to rank the importance of and indicate whether or not they use a series of suggested management responses (Table 4-10).

Table 4-9. Mean Importance Rankings and Standard Deviations of Sources of Risk and Variability in Livestock Production

| No. | Source of Risk and Variability | Mean Ranking of Importance | Standard Deviation | Ranking Class |
|---|---|---|---|---|
| 1 | Livestock and product prices | 3.74 | 1.13 | Very Important |
| 2 | Weather variability | 3.59 | 1.50 | |
| 3 | Diseases and pests | 3.22 | 1.39 | |
| 4 | Cost of operating inputs | 3.19 | 1.33 | |
| 5 | Personal safety and health | 2.83 | 1.47 | Moderately Important |
| 6 | Inflation | 2.70 | 1.68 | |
| 7 | World economic situation | 2.55 | 1.55 | |
| 8 | Cost of capital equipment | 2.55 | 1.58 | |
| 9 | Theft of equipment, etc. | 2.17 | 1.48 | |
| 10 | Federal and state laws | 2.10 | 1.48 | |
| 11 | Family plans | 1.97 | 1.56 | Not Important |
| 12 | Changes in technology | 1.87 | 1.52 | |
| 13 | Cost of credit | 1.85 | 1.96 | |
| 14 | Use of leverage | 1.67 | 1.44 | |
| 15 | Hired labor | 1.62 | 1.78 | |
| 16 | Availability of loan funds | 1.61 | 1.51 | |
| 17 | Government agricultural programs | 1.57 | 1.74 | |
| 18 | Leasing | 0.85 | 1.37 | |

Table 4-10. Mean Importance Rankings and Standard Deviations of Management Responses Towards Risk and Variability in Both Crop and Livestock Production

| No. | Management Response | Mean Ranking of Importance | Standard Deviation | Ranking Class | Percentage of Farmers Using Response |
|---|---|---|---|---|---|
| 1 | Enterprise diversification | 3.87 | 1.52 | Very Important | 83.0 |
| 2 | Pacing of investment and expansion | 3.77 | 1.42 | | 87.5 |
| 3 | Market information | 3.69 | 1.45 | | 89.4 |
| 4 | Government commodity programs | 3.58 | 1.53 | | 87.2 |
| 5 | Maintaining financial reserves | 3.58 | 1.53 | | 74.5 |
| 6 | Production practices diversification | 3.47 | 1.44 | | 87.2 |
| 7 | Maintaining feed reserves | 3.46 | 1.67 | | 74.5 |
| 8 | Spreading sales | 3.04 | 1.70 | | 74.5 |
| 9 | All-risk crop insurance | 3.02 | 1.90 | | 67.4 |
| 10 | Maintaining flexibility in farm organization | 2.90 | 1.48 | Moderately Important | 70.8 |
| 11 | Forward contracting | 2.87 | 1.85 | | 74.5 |
| 12 | Off-farm activities by other family members | 2.60 | 1.95 | | 54.2 |
| 13 | Idling production capacity | 2.56 | 1.37 | | 48.3 |
| 14 | Debt management | 2.48 | 1.99 | | 47.9 |
| 15 | Holding inventory reserves | 2.42 | 1.75 | | 56.5 |
| 16 | Off-farm activities by farm operator | 2.17 | 2.13 | | 41.7 |

Table 4-10. Continued

| No. | Management Response | Mean Ranking of Importance | Standard Deviation | Ranking Class | Percentage of Farmers Using Response |
|---|---|---|---|---|---|
|  |  |  |  | Not Important |  |
| 17 | Holding credit reserve | 1.96 | 1.82 |  | 45.8 |
| 18 | Utilizing government credit program | 1.94 | 1.89 |  | 43.8 |
| 19 | Geographical diversification | 1.50 | 1.69 |  | 19.2 |
| 20 | Use of futures market | 0.87 | 1.25 |  | 8.5 |
| 21 | Hail insurance | 0.58 | 0.77 |  | 6.5 |

Not surprisingly, there is considerable overlap between their volunteered responses and their subsequent ranking of the suggested responses. Management practices designed to combat production risks that are given high ranks include diversification and maintaining feed reserves.

A second group of management responses deals with managing price risks. Using market information and spreading sales are the highest ranked practices in this category. Surprisingly, forward contracting is not rated as particularly important even though a majority of farmers use forward contracts. The farmers generally agree that hedging in the futures market is not an important risk-management practice giving it the second lowest rating after hail insurance. Only about 8 percent of the farmers have ever used the futures market. The low rating of hedging is probably a function of lack of familiarity with hedging, the small average farm sizes associated with small quantities produced and the distance and lack of access to the major grain markets with the associated variability in the basis.

High ranked financial risk-management practices include pacing of investments and expansion and maintaining financial reserves. Participation in government commodity programs which affects (limits) both production and price risk is also highly ranked.

## Relationship Between Socioeconomic Characteristics of Farmers and the Importance Attached to the Sources of Risk

It is hypothesized that farmers' attitudes and perceptions towards risk and variability may be related to certain socioeconomic variables such as the size of farm, experience in farming, leverage ratio of the farm and the educational level of the farmer. To investigate possible relationships, chi-square tests are performed with six socioeconomic variables versus the degree of importance attached to each of the 20 risk sources in crop production and 18 sources of risk in livestock production.

In order to eliminate statistical problems associated with low frequencies in cells of the chi-square test, the numerical rankings of the degree of importance attached to each risk source which range from 0 to 5 are reduced to two--either not important (0, 1, 2) or important (3, 4, 5). The six socioeconomic variables tested are experience in farming, state of residence, educational level of farmer, dominant crop grown, size of farm and the leverage ratio of the farm.

Out of the 38 alternative sources of risk in crop and livestock production, 22 have no significant relationship with any of the six socioeconomic variables. The size of farm is related significantly to six sources of risk (Tables 4-11 and 4-12). It is positively related to diseases and pests, costs of operating inputs, theft of farm equipment, inflation and government agricultural programs for livestock production. As the size of farms becomes larger, farmers' perceptions of these five sources of risk increase. Experience in farming is negatively related to risks of changes in family plans in crop production and to the availability of loan funds and cost of credit in livestock production. These results are consistent with the widely held hypothesis that experience helps the farmer to adapt to the risks of farming.

With regard to the state of residence of the farmer, only leasing in crop production has a significant relationship. Florida farmers

Table 4-11. Sources of Risk and Variability in Crop and Livestock Production That Are Positively Related to Socioeconomic Characteristics of Farmers

| Socioeconomic Variable | Level of Statistical Significance[a] | | |
|---|---|---|---|
| | 10% | 5% | 1% |
| Experience in farming | | (a) Use of leverage in livestock production | |
| Educational level | (a) Other climatic factors such as wind in crop production<br>(b) Leasing in crop production<br>(c) Changes in family plans in livestock production | | |
| Size of farm | (a) Diseases and pests in livestock production<br>(b) Costs of operating inputs in livestock production<br>(c) Government agricultural programs<br>(d) Theft of equipment and product in livestock production | (a) Inflation in livestock production | |
| Leverage ratio | | (a) Use of leverage | |

---

[a] The level of statistical significance refers to the probability of making a type 1 error, i.e., rejecting a true null hypothesis that there is no relationship between the two variables in favor of the alternative hypothesis that there is a relationship.

Table 4-12. Sources of Risk and Variability in Crop and Livestock Production That Are Significantly Negatively Related to Socioeconomic Characteristics of Farmers

| Socioeconomic Variable | Level of Statistical Significance[a] | | |
|---|---|---|---|
| | 10% | 5% | 1% |
| Experience in farming | (a) Changes in family plans in crop production | (a) Availability of loans funds in livestock production<br>(b) Cost of credit in livestock production | |
| State of residence | | | (a) Leasing in crop production |
| 1. Alabama | | | |
| 2. Florida | | | |
| Dominant crop grown | | (a) Leasing in production | |
| 1. Peanuts | | | |
| 2. Other crops | | | |
| Size of farm | | (a) Freezes in crop production | |
| Leverage ratio | (a) Changes in technology in crop production<br>(b) Federal and state laws regulations in livestock production | | |

---

[a] The level of statistical significance refers to the probability of making a Type 1 error, i.e., rejecting a true null hypothesis that there is no relationship between the two variables in favor of the alternative hypothesis that there is a relationship.

perceive leasing in crop production as less important than Alabama farmers. Leasing is also the only source of risk significantly related to the dominant crop grown. Farmers who grow peanuts as the dominant or major crop perceive leasing of crop land as a more important problem than other farmers.

## Relationship Between Socioeconomic Characteristics of Farmers and the Risk-Management Responses

It is hypothesized that farmers' responses toward risk and variability are related to or are influenced by their socioeconomic characteristics. A logistic regression (Johnston, 1984, pp. 425-429) is used to investigate whether the use of the risk-management responses by the farmers in the survey area is related to the following socioeconomic variables--experience in farming, state of residence, the dominant or major crop grown, size of the farm, leverage ratio of the farm, educational level of the farmer and the ethnic group or the race of the farmer.

The logit model employed is of the form

$$\ell n \frac{P_i}{1 - P_i} = a_0x_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7 + e_i .$$

where $P_i$ is the probability that the farmer will use a certain risk-management response i and $P_i/(1 - P_i)$ is the odds favoring the use of that particular risk-management response; $x_j$ is the jth socioeconomic variable; $a_j$ is the parameter estimated where $j = 1 \ldots 7$ in this study; $\ell n$ is the natural logarithm and $e_i$ is the error term in the equation which is assumed to be normally distributed with a zero mean and a constant variance.

Solving the model equation for $P_i$ it can be shown that:

$$P_i = \frac{e^{\sum_{j=o}^{7} a_j x_j + e_i}}{1 + e^{\Sigma a_j x_j + e_i}} \qquad \text{or} \qquad P_i = \frac{1}{1 + e^{-\Sigma a_j x_j + e_i}}$$

Theil (1971, pp. 632-633) and Johnston (1984, pp. 426-428) have indicated that the equation can be estimated by maximum likelihood procedures. The logit equation is estimated using the FUNCAT logistic regression program available from SAS 1982 User's Library. In the beginning, all seven explanatory or socioeconomic variables are used but race and education level do not offer any significant explanatory power and are dropped.

After the program is run with this reduction in explanatory variables, six out of the 21 risk-management responses show significant relationships with at least one of the socioeconomic variables (Table 4-13). The six risk-management responses are (a) maintaining financial reserves, (b) holding credit reserves, (c) debt management, (d) utilizing government credit program, (e) off-farm employment by the farm operator and (f) off-farm activities by other members of the family.

Using 10 percent as the maximum acceptable level of statistical significance,[1] the socioeconomic variables that are significantly related to the use of the risk-management responses are as follows:

---

[1] The level of statistical significance refers to the probability of making a Type 1 error, i.e., rejecting the null hypothesis that the parameter value is zero in favor of the alternative hypothesis that the parameter value is significantly different from zero.

Table 4-13. Results of the Logit Regression of the Risk-Management Responses Versus the Socioeconomic Characteristics of Farmers[a]

| Equation Number | Parameter Estimates of Explanatory Variables[b] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Risk-Management Response[c] | Intercept | Experience | State | Crop | Leverage | Size |
| 1 | Maintaining financial reserves | 2.5623<br>(0.1132) | -0.0805<br>(0.0778) | -0.9821<br>(0.1440) | 1.7263<br>(0.0219) | -6.9092<br>(0.0199) | 0.0083<br>(0.0322) |
| 2 | Holding credit reserves | -0.0724<br>(0.4996) | -0.0066<br>(0.8159) | 0.7837<br>(0.0920) | -0.3234<br>(0.4959) | 3.5429<br>(0.0435) | $-8.311\text{x}10^{-6}$<br>(0.9957) |
| 3 | Debt management | -0.8149<br>(0.5121) | 0.0058<br>(0.8603) | -0.4839<br>(0.3453) | 0.2380<br>(0.6388) | 7.8821<br>(0.0089) | -0.0040<br>(0.1237) |
| 4 | Utilizing government credit programs | -3.5228<br>(0.0156) | 0.0846<br>(0.0267) | -1.1796<br>(0.0421) | 1.0217<br>(0.0685) | 4.4444<br>(0.0346) | -0.0014<br>(0.5420) |

Table 4-13. Continued

| Equation Number | Risk-Management Response[c] | Parameter Estimates of Explanatory Variables[b] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Intercept | Experience | State | Crop | Leverage | Size |
| 5 | Off-farm activities by farm operator | 2.9632<br>(0.0481) | -0.0162<br>(0.6542) | -0.3882<br>(0.5147) | 0.2763<br>(0.6837) | 3.7123<br>(0.1132) | -0.0142<br>(0.0090) |
| 6 | Off-farm activities by other family members | 2.7862<br>(0.0400) | -0.0402<br>(0.2228) | 0.0546<br>(0.9043) | -0.3340<br>(0.4878) | 3.2993<br>(0.1059) | -0.0057<br>(0.0135) |

---

[a] The level of statistical significance for each parameter estimate is in parenthesis. The level of statistical significance refers to the probability of making a Type 1 error, i.e., rejecting a true null hypothesis that the parameter value is zero in favor of the alternative hypothesis that the parameter estimate is different from zero.

[b] The explanatory variables are denoted as follows:
Experience--experience in farming in years;
State--the state of residence of the farmer, 0 denotes Alabama and 1 denotes Florida;
Crop--dominant or major crop grown by the farm, 0 denotes peanuts and 1 denotes any other crop;
Leverage--the leverage ratio of the farm; and
Size--is the size of the farm under crops and harvestable forage in acres.

[c] The dependent variable is the use of a certain risk-management response. The use of the management response is denoted by 1 and non-use by 0. However, the actual dependent variable estimated is $\ell n(P_i/1 - P_i) = X_i'\hat{B}$.

## Equation 1: Maintaining Financial Reserves

Maintaining financial reserves becomes increasingly used with increasing size of farm and the growing of a dominant crop other than peanuts. Use of this response, however, decreases with more farming experience and increasing leverage. The small positive coefficient for size of farm suggests that larger farms use more funds and are slightly more apt to hold financial reserves to deal with shocks or unexpected changes in the environment. This result appears inconsistent with the finding that larger farms tend to be more highly leveraged (Table 4-6). Given the magnitude of the coefficient the first result perhaps should be downplayed. Alternatively, it may be that larger farms tend to both use leverage and keep financial reserves.

Peanuts are a restricted crop under the government's commodity program. Farmers cultivating this crop as their dominant crop have more reliable and stable income and appear less likely to maintain financial reserves than those farmers growing other crops as their dominant crop. Experience in farming leads to declining use of financial reserves as the increased skills of the farmers allow them to adapt to the risky and uncertain environment. Increasing leverage of the farm decreases the use of this management response as normally financial reserves will be used before extensive debt levels are incurred.

## Equation 2: Holding Credit Reserves

Holding credit reserves is used increasingly with increasing leverage. This result may indicate that farmers misunderstood what was meant by a credit reserve or it may suggest that farmers who tend to use credit appreciate the importance of a credit reserve. Florida farmers appear to use this management response more on the average than Alabama farmers.

## Equation 3: Debt Management

The use of debt management as a risk-management tool increases with increasing leverage. This statement implies that the increasing debts to assets ratio requires the management of debts to maintain stable and healthy growth and to avoid farm bankruptcy. Farmers who are more highly leveraged, therefore, have to manage their debts more carefully in order to run their farm business successfully.

## Equation 4: Utilizing Government Credit Programs

Utilizing government credit programs such as Farmers Home Administration loans increases with increasing leverage of the farm, experience in farming[2] and the cultivation of non-peanut crops as the dominant crop by the farmer. Increasing leverage of the farm leads to increasing use of government disaster loans and Farmers Home Administration loans. The cultivation of crops other than peanuts as the dominant crop means that the farmer is less likely to achieve the more stable and reliable income obtained from peanuts. Since peanuts are a restricted crop under the federal government agricultural program, this result means that there is a trade off in the use of government agricultural programs. Farmers not currently participating in the peanuts program are more likely to utilize government credit programs. Finally, Florida farmers appear less likely to utilize government credit programs than Alabama farmers.

---

[2] This result appears inconsistent with normal expectations since more experienced farmers are expected to rely less on government subsidized credit. However, the responses to this question are based on whether they have ever used government credit programs during their career not whether they are currently using the programs.

### Equation 5: Off-Farm Activities by the Farm Operator

The use of this risk-management response is negatively related to the size of the farm. Larger farms require the full attention to the operator and hence there is less time for the operator to devote to off-farm activities.

### Equation 6: Off-Farm Activities by Other Members of the Family

The use of this management response is also inversely related to the size of the farm. The explanation may be that larger farms may require the labor services of the other members of the family thus depriving them of time to do off-farm jobs.

The use of off-farm activities by other members of the family appears to increase with increasing leverage of the farm (see Table 4-13). This finding is intuitively appealing since higher leveraged farmers may tend to require funds generated by off-farm activities in order to meet cash flow requirements.

The results of the farm risk survey analysis have been presented in this chapter. The next chapter, Chapter 5, deals with the results of risk-efficiency analysis of various risk-management scenarios for a typical middle-sized, mixed crop farm in North Florida. The characteristics of the farms determined from the risk survey are used as data to establish the various risk-management scenarios, and also for financial risk analysis and other analyses.

# CHAPTER 5
# RESULTS OF THE STOCHASTIC MODELING ANALYSIS OF THE VARIOUS RISK-MANAGEMENT SCENARIOS FOR THE TYPICAL FARM

## Evaluation of the Income Simulation Model

Before the income simulation can be used to analyze risk-efficient management scenarios, the model itself has to be verified and then validated. The verification and validation constitute the evaluation of the model. Verification involves the testing of the operation of the model and it starts by checking the individual components of the model before attacking the whole model.

The income simulation model is verified by running the model and fixing all the input data at the same constant values. The results obtained are cross-checked with those obtained through manual calculations of the incomes for the different risk-management scenarios. Secondly, the random number seed generators in both the main program and the net output price generator subroutine are checked for consistency by printing out the results of the random numbers.

Dent and Blackie (1979) and Csaki (1985) have summarized the basic concepts of agricultural systems simulation model validation. They argue that since a simulation model is an abstraction of reality and an approximation to the functioning of the real system, the problem of model validation has to be seen as determining whether the model built is an adequate representation of reality. The model is not supposed to establish the "truth" in the absolute sense. The validation of the income simulation model is done within this spirit.

The income model built generates incomes under different risk-management scenarios. Some scenarios are close to the risk-management techniques employed by North Florida farmers at the time of the survey. The other scenarios modeled are basically hypothetical in nature; however, they have potential use for farmers, for example, scenarios involving hedging and put options in the futures market, which are not being used by most North Florida farmers due partly to the lack of familiarity of the working and profitability of the futures marketing strategies.

Out of the 16 risk-management scenarios modeled (see Table 3-2) the six scenarios presented in Table 5-1 are close to what are being employed by farmers in the North Florida area. These six scenarios are chosen because the survey results (Chapter 4) indicate that about 75 percent of the farmers use a mix of cash sales at harvest time and forward contracting as a marketing tool to reduce risk. Only 8.5 percent of the sample farmers use hedging. The futures put options was just recently introduced (in early November 1984) and most farmers obviously have little experience with this marketing tool. Also, given the current low farm prices, row crop production on sands soils is not profitable. These soils tend to be used for winter wheat, pasture or left idle. If row crops are grown, they are generally irrigated. Therefore, scenarios 1, 2, 4, 5, 6 and 8 are the scenarios that resemble current risk-management practices of typical farms in North Florida out of the 16 scenarios modeled in this study.

Table 5-1. Mean and Standard Deviations of Incomes of the Six Most Likely Used Risk-Management Scenarios Modeled in the Income Simulation Model

| Scenario No. | Description of Scenario | Mean Income Dollars[a] |
|---|---|---|
| 1 | Production--crops are grown on sands soils and irrigated. Marketing of crops is through cash sales at harvest time only. | 27,197.60<br>(11,593.19) |
| 2 | Production--crops are grown on sandy-loam soils and irrigated. Marketing of crops is through cash sales at harvest time only. | 31,931.73<br>(11,807.20) |
| 4 | Production--crops are grown on sandy-loam soils and not irrigated. Marketing of crops is through cash sales at harvest time only. | 17,956.70<br>(13,161.96) |
| 5 | Production--crops are grown on sands soils with irrigation. Marketing is carried out as a mix of cash sales at harvest time and forward contracting. About 50 percent of the 17 years average yields of the four crops are forward contracted. | 21,688.84<br>(6,654.16) |
| 6 | Production--crops are grown on sandy-loam soils with irrigation. Marketing is carried out as a mix of cash sales at harvest time and forward contracting. About 50 percent of the 17 years average yields of the four crops are forward contracted. | 26,337.42<br>(6,780.66) |
| 8 | Production--crops are grown on sandy-loam soils without irrigation. Marketing of crops is done as a mix of cash sales at harvest time and forward contracting same as in scenarios 5 and 6. | 14,708.87<br>(11,631.21) |

[a] The standard deviations of income are in parentheses.

Table 5-2 presents the actual 1982 taxable mean farm incomes for different categories of farmers derived from the 1983 farm risk survey. Since farm incomes and prices have been generally more stable from 1982 to 1984, when coupled with the fact that the inflation rate has been relatively stable and low in the same period, the 1982 non-taxable farm incomes are reasonable indicators of the 1984 farm incomes.

Tables 5-1 and 5-2 show that the simulated incomes are generally quite close to the actual incomes considering the variability of the incomes. For example, from Table 5-1 a simple average of the incomes for scenarios 1, 2 and 4 (those scenarios involving only cash sales at harvest time only) is $25,695.34 while the average for scenarios 5, 6 and 8 (those scenarios involving a mix of cash sales and forward contracting) is $20,911.71 for the 235 acre model farm. The model farm is 15 acres smaller than the midpoint of the 200-300 acres group of farms obtained from the survey. The simulated incomes allowing for a 250 acre farm will be $27,335.46 and $22,246.50, respectively, for scenarios involving only cash sales at harvest time only and those involving a mix of cash sales and forward contracting. These simulated incomes are slightly higher than the actual mean incomes of the 200-300 acres group of farms obtained from the survey (see Table 5-2). One reason for this difference may lie in the fact that the costs of the inputs held constant in the simulation model may vary slightly in the real world.

For the income simulation model to be regarded as a good approximation of reality it has to be able to predict some of the behavior of the real world farms in North Florida. The 1983 farm risk survey indicates that about 75 percent of all the sample farms use a mix of

Table 5-2. Actual 1982 Taxable Mean Incomes for the Different Categories of Farms in Dollars Derived from a Survey of Farmers in North Florida and South Alabama

| Category of Farms | Number of farms[a] | Mean Income in Dollars |
|---|---|---|
| All farms | 42 | 24413.00 |
| Farms using forward contracting | 30 | 24329.00 |
| Farms between 150 and 500 acres | 21 | 21903.00 |
| Farms between 200 and 300 acres | 5 | 21250.00 |
| Farms between 200 to 300 acres that use forward contracting[b] | 5 | 21250.00 |

[a] The number of farms correspond to only those that the income information sought could be obtained.

[b] All farms in the size range of 200 to 300 acres use forward contracting as a management tool.

cash sales at harvest time and forward contracting as a risk-management tool. Hence the income probability distribution from the simulation model should be able to detect such a behavior when subjected to the stochastic dominance with respect to a function analysis.

Table 5-3 indicates that the risk-efficient set of scenarios includes those involving a mix of cash sales at harvest time and forward contracting for farmers classified as highly risk averse and very highly risk averse. In fact for the very high risk-averse farmers (i.e., those with absolute risk-aversion coefficients betwen 0.00050 and 0.001), scenario 6 (a scenario involving a mix of cash sales and forward contracting) dominates all other 15 scenarios considered.

The income simulation model appears, therefore, to have passed two critical tests of validation.

## Results from the Analysis of the Base Model of the Typical Farm

The base model of the typical farm is based on the assumption that the certain prices and costs are held constant at their 1984 planting time levels. The results from the analysis of the base model are reported in this section. In the next section, more detailed results involving sensitivity analysis of changes in some of the fixed parameters in the model are presented.

### Sample Size and Risk-Efficiency Rankings of Farm Plans

It is hypothesized that the number of Monte Carlo replications of income or the sample size used to generate the cumulative probability distribution of income for the various risk-management scenarios (farm plans) will not affect the choice of risk-efficient scenarios by

Table 5-3. Efficient Set of Risk-Management Scenarios According to the Utility Groups of Farmers and the Sample Size or the Number of Replications Used to Estimate the Cumulative Probability Distribution of Income for the Typical Farm in North Florida under 1984 Conditions[a]

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Sample Size and Percent of Local Risk Universe[b] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 50 (19.6%) | 100 (39.2%) | 125 (49.0%) | 150 (58.8%) | 200 (78.4%) | 300 (117.6%) | 500 (196.1%) |
| -0.00050 to -0.00001 | Moderate Risk Lover | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| -0.00001 to 0.00000 | Low Risk Lover | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0.00000 to 0.00000 | Risk Neutral (maximizers of expected profits) | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0.00000 to 0.00001 | Very Low Risk Averse | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0.00001 to 0.00003 | Low Risk Averse | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0.00003 to 0.00010 | Moderate Risk Averse | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Table 5-3. Continued

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Sample Size and Percent of Local Risk Universe | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 50 (19.6%) | 100 (39.2%) | 125 (49.0%) | 150 (58.8%) | 200 (78.4%) | 300 (117.6%) | 500 (196.1%) |
| 0.00010 to 0.00050 | High Risk Averse | 2 | 2 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |
| 0.00050 to 0.00100 | Very High Risk Averse | 2,6,10,14 | 2,6,10,14 | 6 | 6 | 6 | 6 | 6 |
| 0.00000 to 0.00100 | Second Degree Stochastic Dominance | 2 | 2 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |
| -0.00100 to 0.00100 | First Degree Stochastic Dominance | 2 | 2 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |

---

[a] The typical farm is a medium-sized farm of 235 acres growing corn, peanuts, soybeans and winter wheat.

[b] The local risk universe consists of a total of 255 combinations of 17 production or "weather" years and 15 price years.

different groups of farmers. Several agricultural economists have arbitrarily used a sample size of 100 to generate the cumulative probability distribution of income.

In this study, various sample sizes are used to generate the cumulative probability distributions of income and stochastic dominance with respect to a function analysis applied to determine the risk-efficient set of scenarios for the various groups of farmers. Table 5-3 presents the risk-efficient set of scenarios according to the sample size used to estimate the cumulative probability distribution of income.

It can be observed that sample sizes of 50 or 100 rank the scenarios similarly. However, when the sample size is increased to 125 or beyond, the risk-efficient set of scenarios changes for different groups of farmers. Using a sample size of 50 or 100 leads to a different ranking compared to the other sample sizes for four out of the ten groups of farmers specified in the study. These groups are high risk averse, very high risk averse, second degree stochastic dominance and first degree stochastic dominance groups. The random number seed in both the main program and subroutine in the income simulation model is changed randomly 10 times and the risk-efficient set determined each time for the sample sizes of 50 and 100 to determine whether there will be any changes. The results obtained each time indicate the same risk-efficient set of scenarios for these sample sizes which differ from those of the other larger sample sizes (125 and above).

The local risk universe is defined in this study as the total number of possible combinations obtained from variation of the stochastic parameters in the base model. This model has 17 possible "production" years and 15 possible "price" years giving a total number of combinations or a local risk universe of 255. Recall that all the other parameters in the model are held constant at their 1984 levels. Hence, the sample sizes of 50 and 100 constitute 19.6 percent and 39.2 percent of the local risk universe, respectively, while the sample size of 500 is 196.1 percent of the local risk universe (Table 5-3). Table 5-3 indicates that the lower the percentage of the local risk universe that is used for generating the cumulative probability distribution of income, the higher the chances of obtaining incorrect rankings[1] of the risk-management scenarios.

The above results support the findings of Kroll and Levy (1980) and Pope and Ziemer (1984). Both studies conclude that the frequency of incorrect rankings decreases rapidly with larger sample sizes. Hence an arbitrarily chosen sample size of 100 does not appear to be justified by this empirical work. These observations appear more important considering the fact that testing the differences among the mean incomes of the scenarios according to the sample size using the SAS PROC TEST program reveals no significant differences. Therefore, a researcher basing the sample size on the significance of the differences among the mean incomes of the various farm plans may choose a low sample size such as 50 or 100 as a computer cost-saving technique. However, this will clearly lead to incorrect rankings for this study.

---

[1] The risk-efficiency rankings are regarded as correct for sample sizes or 125 and above because the risk-efficient set of the management scenarios derived are similar to the actual use of risk-management responses obtained from the survey of farmers reported in Chapter 4.

In other words, the optimum sample size to be used in risk-efficiency analysis cannot be decided solely on testing the statistical significance of the differences among the mean incomes but more importantly by examining the ranking of choices using the entire probability distributions of income.

An initial logical choice of an optimum sample size is the local risk universe which is equivalent to all the possible combinations of the sources of risk. In this study, the risk universe is 255 as derived earlier. The choice of the local risk universe as the initial optimum sample size is based on the fact that it is most likely that all possible combinations of the sources of risk may be covered in the simulation modeling. However, the costs of computer time and the degree of accuracy desired by the researcher are important factors to consider in the final choice of the optimum sample size. The minimum sample size that results in the correct risk-efficiency rankings is 125 For the rest of the study, however, the sample size of 500 is used to generate the cumulative probability distribution of income. This sample size is chosen to ensure much greater accuracy of the results and increase the chances of all possible combinations of the risk sources being selected by the simulation model at least once.

## Other Results Derived from the Base Model Analysis

Table 5-4 reports the means, standard deviations and the coefficient of variation of incomes for the various risk-management scenarios. Production on sandy-loam soils with irrigation combined with marketing of the crops by cash sales at harvest time only (scenario 2) results in the highest mean income. Not surprisingly,

Table 5-4. Means, Standard Deviations and the Coefficients of Variation of Incomes for the Various Risk-Management Scenarios for the Typical North Florida Farm (Base Model) in 1984 Dollars

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|---|
| 1 | Production--sands soils with irrigation. Marketing--cash sales at harvest time only. | 27,197.60 | 11,593.19 | 0.43 |
| 2 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest time only. | 31,931.73 | 11,807.20 | 0.37 |
| 3 | Production--sands soils with no irrigation. Marketing--cash sales at harvest time only. | 3,107.91 | 11,752.54 | 3.78 |
| 4 | Production--sandy-loam soils with no irrigation. Marketing--cash sales at harvest time only. | 17,956.70 | 13,161.96 | 0.73 |
| 5 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 21,688.84 | 6,654.16 | 0.31 |

Table 5-4. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|---|
| 6 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales and forward contracting. | 26,337.42 | 6,780.66 | 0.26 |
| 7 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 609.23 | 10,692.24 | 17.55 |
| 8 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 14,708.87 | 11,631.21 | 0.79 |
| 9 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and hedging. | 22,784.03 | 7,782.89 | 0.34 |
| 10 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest and hedging. | 27,518.17 | 7,994.03 | 0.29 |

Table 5-4. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|---|
| 11 | Production--sands soils without irrigation. Marketing--mix of cash sales at harvest and hedging. | 1,232.21 | 10,941.68 | 8.88 |
| 12 | Production--sandy-loam soils without irrigation. Marketing--mix of cash sales at harvest and hedging. | 16,081.00 | 12,203.85 | 0.76 |
| 13 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,133.84 | 9,746.55 | 0.42 |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 27,867.97 | 10,010.56 | 0.36 |
| 15 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 1,349.11 | 11,273.25 | 8.36 |

Table 5-4. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|---|
| 16 | Production--sandy-loam soils with no irrigation.<br>Marketing--mix of cash sales at harvest and futures options. | 16,197.90 | 12,635.91 | 0.78 |

scenario 2 dominates all the other 15 scenarios considered for groups of farmers classified as moderate risk lovers, low risk lovers, risk neutral, very low risk averse, low risk averse and moderately risk averse (Table 5-3; sample size 500).

However, for high risk-averse and very high risk-averse groups the above result no longer holds. For very high risk-averse farmers, scenario 6 involving a mix of cash sales and forward contracting marketing strategy dominates all the other scenarios. Scenario 6 also has the lowest coefficient of variation of income (Table 5-4). Forward contracting reduces income variability and even though it results in lower incomes than cash sales at harvest time, it is appealing to the very high risk-averse farmers.

Another important result is that the scenarios involving the production of the crops on sands soils (scenarios 1, 3, 5, 7, 9, 11, 13, 15) generate much lower incomes and higher coefficients of variation of incomes than their corresponding risk-management scenarios involving sandy-loam soils (2, 4, 6, 8, 10, 12, 14, 16). The obvious reason is that sandy-loam soils are more productive than the sands soils due to the greater water holding capacities. One way of reducing the high income variability on sands soils is to use irrigation. Hence scenarios 1, 5, 9, 13 which involve irrigated sands soils have much higher income and lower coefficients of variation of incomes than their corresponding non-irrigated scenarios (3, 7, 11 and 15, respectively).

It is also hypothesized that different groups of farmers choose different risk-management scenarios or farm plans because of their risk attitudes or the degree of risk aversion. Table 5-3 confirms this hypothesis and is also supported by the results of the farm risk survey reported in Chapter 4. The discriminating power of the stochastic dominance program employed in this study is also highlighted. Table 5-3 illustrates that when the risk-aversion coefficients intervals are reduced in size or narrowed, it leads to the reduction of the risk-efficient set of scenarios. First and second degree stochastic dominance rules result in a risk-efficient set containing scenarios 2, 6, 10 and 14. The set is reduced to only one--scenario 2 for the first six groups of farmers reported in Table 5-3 and also to only one scenario (6) for the very high risk-averse farmers.

Table 5-5 reports the theoretical probabilities of the typical farm achieving incomes less than three specified critical income levels. The three critical income levels correspond to the short-term debts obligations of different categories of farmers in the 1983 survey of farmers reported in Chapter 4.

The risk-management scenarios with the highest probabilities of not achieving the critical incomes are scenarios 3, 7, 11 and 15. These four scenarios involve production of the four crops on sands soils without irrigation. These four scenarios have over an 80 percent chance that the farm cannot generate incomes of $15,000 or more to meet short-term debts. The $15,000 figure represents the average short-term debts of farms between 200-300 acres derived from the 1983 survey.

Once again, it must be emphasized that the use of irrigation on sands soils is essential to increase incomes and reduce income variability at least in the short run and also to reduce significantly the chances of the farm not being able to meet short-term debts. Irrigation on sands soils reduces the probability of failure to meet short-term debts obligations substantially. For example, scenario 3

Table 5-5. Probabilities of the Model Typical Farm Achieving Less Than the Different Levels of Critical Income (Amount of Short-Term Debts Obligations) for the Different Risk-Management Scenarios for 1984 Conditions

| Risk-Management Scenario or Farm Plan Number | Amount of Short-Term Debts Obligations in Dollars | | |
|---|---|---|---|
| | Zero[a] | 12,500[b] | 15,000[c] |
| 1 | 0.002 | 0.110 | 0.154 |
| 2 | 0.000 | 0.052 | 0.086 |
| 3 | 0.398 | 0.756 | 0.824 |
| 4 | 0.056 | 0.406 | 0.466 |
| 5 | 0.000 | 0.092 | 0.156 |
| 6 | 0.000 | 0.016 | 0.068 |
| 7 | 0.452 | 0.846 | 0.916 |
| 8 | 0.102 | 0.470 | 0.522 |
| 9 | 0.000 | 0.106 | 0.152 |
| 10 | 0.000 | 0.030 | 0.058 |
| 11 | 0.450 | 0.826 | 0.890 |
| 12 | 0.076 | 0.452 | 0.488 |
| 13 | 0.002 | 0.144 | 0.206 |
| 14 | 0.000 | 0.056 | 0.092 |
| 15 | 0.448 | 0.790 | 0.896 |
| 16 | 0.078 | 0.456 | 0.498 |

[a] This level of income corresponds to the short-term debts of 37.5 percent of the sample farmers in the 1983 survey reported in Chapter 4.

[b] This level of income corresponds to the short-term debts obligations of 25 percent of the sample farmers in the 1983 survey.

[c] Corresponds to the average short-term debts of farms between 200 to 300 acres in the 1983 survey. The model farm is 235 acres, a middle-sized farm.

has 0.824 probability of not being able to generate enough income to pay $15,000 during the production year. However, its counterpart irrigated scenario--scenario 1--has only a 0.154 probability, a substantial reduction of 0.67. These conclusions, however, have to be tempered in light of work done by Boggess and Amerling in 1983 under similar North Florida conditions. They establish that even though irrigation is normally a risk-reducing input, irrigation investments are quite risky over the long term. The farmer who invests in irrigation equipment trades a reduction in production risk for an increase in financial risk over the long term due to changes in weather and economic conditions.

## Evaluation of the Marketing Strategies

Using sample size 500 scenario 2--the most profitable scenario or farm plan involving cash sales at harvest time--only dominates all the other 15 scenarios considered for moderate risk lovers up to moderate risk-averse farmers (Table 5-3). Its clear domination of the other scenarios ceases for high risk-averse farmers and very high risk-averse farmers; scenario 2 is only one of four members of the risk-efficient set for those two groups. The other scenarios are 6, 10 and 14. These three scenarios involve production of the crops on sandy-loam soils with irrigation; however, they represent different marketing strategies. The marketing strategies used under scenarios 6, 10 and 14 are a mix of cash sales at harvest with forward contracting, a mix of cash sales plus hedging and a mix of cash sales and future options, respectively.

A very interesting question to be asked then is what types of results are obtained when these latter three marketing strategies are compared (in the absence of cash sales at harvest time only scenarios). To answer this question the risk-efficiency comparisons of the three marketing strategies for the different groups of farmers are presented in Table 5-6. It can be observed that the scenario containing forward contracting is dominated by the scenario involving hedging except in the case of high risk-averse and very high risk-averse groups of farmers. The degree of domination declines with the increasing degree of risk aversion. Futures put options also dominate forward contracting for moderate risk lovers up to moderate risk-averse I groups of farmers. As the degree of risk aversion increases beyond that of moderate risk averse II, forward contracting dominates futures put options as a marketing strategy.

Futures put options dominate hedging for risk lovers and very low risk-averse farmers. Hedging, in turn dominates futures options for moderate risk-averse, high risk-averse and very high risk-averse farmers. In general, therefore, it appears that futures put options is the most preferred marketing strategy after cash sales at harvest time, followed by hedging and then forward contracting for risk lovers and low risk-averse farmers. However, for very high risk-averse farmers, the reverse holds true. Forward contracting is the most preferred strategy, followed by hedging then futures put options and cash sales at harvest time for this group of farmers. Finally, it must be noted that highly risk-averse farmers are indifferent between hedging and forward contracting while moderate risk-averse II group of farmers are indifferent between futures options and forward contracting. Hence it

Table 5-6. Risk-Efficiency Comparisons of Three Marketing Alternatives Available to the Typical Farm in North Florida--Forward Contracting, Hedging and Futures Put Options under 1984 Conditions for the Different Utility Groups of Farmers[a]

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Forward Contracting Versus Hedging (Scenario 6 Versus Scenario 10) | Forward Contracting Versus Futures Put Options (Scenario 6 Versus Scenario 14) | Hedging Versus Futures Put Options (Scenario 10 Versus Scenario 14) |
|---|---|---|---|---|
| -0.00050 to -0.00001 | Moderate Risk Lover | -1 | -1 | -1 |
| -0.00001 to 0.00000 | Low Risk Lover | -1 | -1 | -1 |
| 0.00000 to 0.00000 | Risk Neutral | -1 | -1 | -1 |
| 0.00000 to 0.00001 | Very Low Risk Averse | -1 | -1 | -1 |
| 0.00001 to 0.00003 | Low Risk Averse | -1 | -1 | 0 |
| 0.00003 to 0.00005 | Moderate Risk Averse I | -1 | -1 | 1 |
| 0.00005 to 0.00007 | Moderate Risk Averse II | -1 | 0 | 1 |

Table 5-6. Continued

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Forward Contracting Versus Hedging (Scenario 6 Versus Scenario 10) | Forward Contracting Versus Futures Put Options (Scenario 6 Versus Scenario 14) | Hedging Versus Futures Put Options (Scenario 10 Versus Scenario 14) |
|---|---|---|---|---|
| 0.00007 to 0.00010 | Moderate Risk Averse III | -1 | 1 | 1 |
| 0.00010 to 0.00050 | High Risk Averse | 0 | 1 | 1 |
| 0.00050 to 0.00100 | Very High Risk Averse | 1 | 1 | 1 |
| 0.00000 to 0.00100 | Second Degree Stochastic Dominance | 0 | 0 | 0 |
| -0.00100 to 0.00100 | First Degree Stochastic Dominance | 0 | 0 | 0 |

---

[a] A -1 indicates the scenario listed first is dominated by the scenario listed second, 1 indicates that the first scenario dominates the second, and 0 indicates that the members of the utility group are indifferent between the two.

appears that the marketing strategies may be complementary to each other for certain groups of farmers and may be used as a combination to reduce price risk.

The results obtained from comparing the three marketing strategies can be explained by an analysis of the basis and changes in the average futures prices. Figures 5-1 and 5-2 represent the variation in the basis for corn and soybeans, respectively. A casual look at the two figures reveals that the basis for both crops is quite variable and not the relatively constant value sometimes emphasized in text books. The basis is even more unstable for corn and is negative in some years (see Figure 5-1). The average basis for corn is $0.07 with a coefficient of variation of 2.41. For the soybean crop, the basis is $0.37 with the coefficient of variation of 0.46.

Two reasons may account for the relatively high variability in the corn basis. First, corn in Florida is harvested in July and August rather than October and November when the major producing areas of the United States harvest. Thus, the Florida harvest time price is very sensitive to weather market effects in the Midwest. Soybeans, on the other hand, are harvested primarily in October and November throughout the nation. Secondly, there is both a local and a national market for corn, whereas there is only a national market for soybeans. Thus, the local supply and demand conditions for corn can be significantly different from the national supply and demand situations. The relatively lower variability in the soybeans basis may partly explain why it is the main crop traded in the futures market by North Florida farmers.

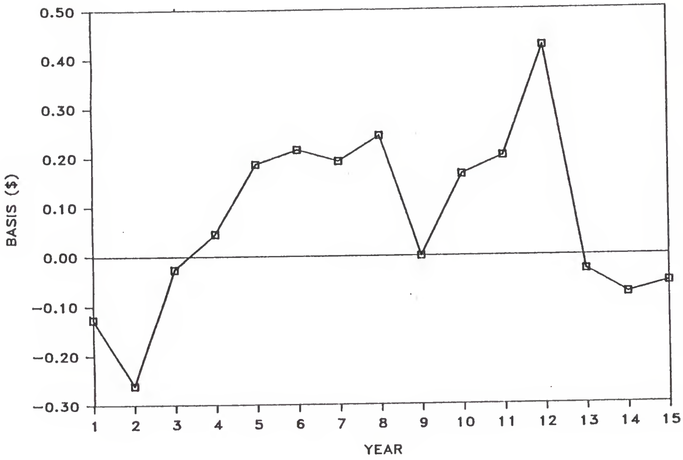


Figure 5-1. Variation in the Basis for August (Harvest Time) Corn in North Florida.

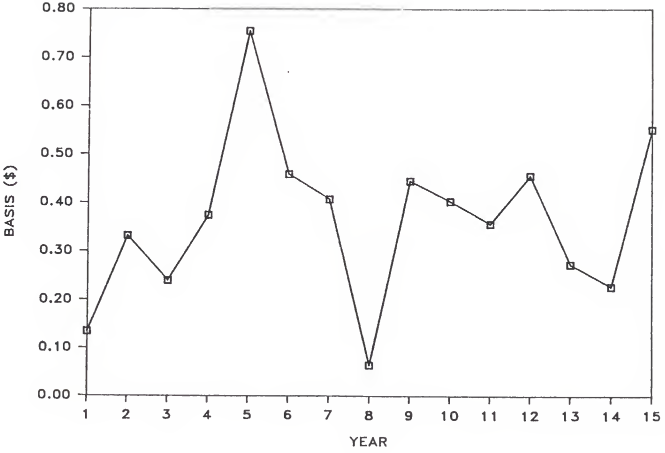


Figure 5-2. Variation in the Basis for November (Harvest Time) Soybeans in North Florida.

The hedging marketing strategy is supposed to protect the farmer from price risk through a stable basis. The net output price of the crop under hedging is the futures price at planting time less the basis less the commission and brokerage fees. High variability in the basis makes the achievement of stable output prices more difficult. Hence forward contracting marketing strategy for which the final net output price of the crop is known at planting time appears more appealing than hedging for farmers very much concerned about income stability such as the very high risk-averse farmers.

With regards to the futures options marketing strategy, there are two sources of price risk which the farmer has to take into consideration. The first is the variation in the basis which has already been discussed. The second is the change in the futures price between planting time and expiration of the options. The expiration date is considered to be one month before the delivery month of the underlying futures contracts (or the harvest time) in this study.

Figures 5-3 and 5-4 present the change in futures prices (CIFP) for corn and soybeans, respectively. The average CIFP's are 0.11 and 0.27 for corn and soybeans, respectively. The coefficients of variation are 5.15 and 5.57, respectively, indicating the high variability in the futures prices. The signal from the high variability is that the farmer has a potential of using the options market to gain higher income. With some degree of probability, the change in futures prices may exceed the premium paid for using the options market, and the farmer may gain more income than under hedging or forward contracting. In the base model, the initial strike prices are set at \$3.00 and \$7.50 with the premiums being \$0.08 and \$0.66 for corn

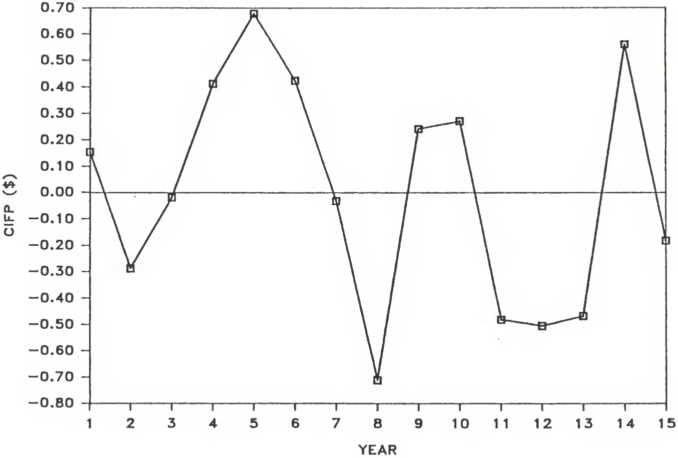


Figure 5-3. Change in Futures Prices (CIFP) for Corn from Planting Time (March) to the Time of Delivery of the Futures Options (August).

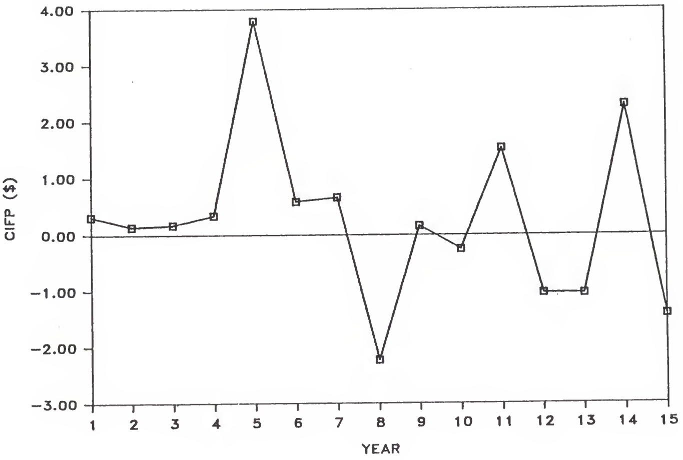


Figure 5-4. Changes in Futures Prices (CIF)) for Soybeans from Planting Date (May) to the Time of the Delivery of the Futures Options (October).

and soybeans, respectively. The CIFP exceeds the premiums seven out of 15 times or a probability of 0.47 for corn and three out of 15 years or a probability of 0.20 for soybeans (Figures 5-3 and 5-4). There is, therefore, some significant chance for the farmers to reap extra profits with the options strategy, particularly in the case of corn. However, there is also a significant chance that the premium paid for the option will exceed the CIFP and that the farmer will receive a lower net price than if he had hedged. Hence for risk lovers and low risk-averse farmers, the futures option marketing strategy seems more attractive than hedging and forward contracting. However, for high and very high risk-averse farmers, the options loses its attraction first to forward contracting and then to hedging.

## Sensitivity Analysis Involving Changes in the Parameters in the Base Model

The results of the previous section have been derived keeping certain parameters in the model at the 1984 levels. In this section, selected parameters values are varied and the impacts of the changes on the risk-efficient set of the management scenarios are analyzed.

The main parameters in the income simulation model to be varied are as follows:

(a) the 1984 total costs of irrigation;
(b) the acreage allotment for peanuts;
(c) the amounts of corn and soybeans contracted in the futures market;
(d) amounts of the four crops forward contracted; and

(e) the strike prices and hence the corresponding premiums under the futures options marketing strategy for corn and soybeans.

The results of the sensitivity analysis involving changes in the levels of the above factors are discussed below.

## Variation in the 1984 Total Costs of Irrigation

The total costs of irrigation in the base model are kept at the 1984 level for all the crops irrigated. The total costs of irrigation are then increased by 50 percent, 75 percent and 100 percent above the 1984 level to perform the sensitivity analysis.

Table 5-7 reports the mean incomes and the coefficient of variation of income for the eight irrigated scenarios modeled with the changes in the total costs of irrigation. Increases in the costs of irrigation, as expected decrease the mean income of all the scenarios considered. Also, the coefficient of variation of income increases with increasing total costs. As total irrigation costs increase by 75 percent above the 1984 level, the non-irrigated sandy-loam scenarios become the most profitable scenarios. Thus, scenario 4 has the highest income for increases of 75 percent and above (Table 5-7).

Table 5-8 presents the risk-efficient set of the risk-management scenarios for the different groups of farmers with the variation in the total costs of irrigation. It can be observed that the risk-efficient set of scenarios varies according to the level of increase in the total irrigation costs above the 1984 level. For increases in total irrigation costs of 75 percent or over, scenario 4, a non-irrigated scenario dominates all the other scenarios for moderate risk-lovers, low

Table 5-7. Mean Incomes and the Coefficient of Variation of Incomes[a] for the Various Irrigated Risk-Management Scenarios with Variation in the Total Costs of Irrigation for the Typical North Florida Farm[b] in 1984 Dollars

| Risk-Management Scenario | Description of Risk-Management Scenario | Increase in the 1984 Total Irrigation Costs | | | |
|---|---|---|---|---|---|
| | | 0%[c] | 50% | 75% | 100% |
| 1 | Production--sands soils with irrigation. Marketing--cash sales at harvest time only. | 27,197.60<br>(0.43) | 15,874.25<br>(0.73) | 10,236.35<br>(1.14) | 4,574.69<br>(2.55) |
| 2 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest time only. | 31,931.73<br>(0.37) | 22,142.68<br>(0.54) | 17,266.71<br>(0.69) | 12,372.19<br>(0.97) |
| 5 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 21,688.84<br>(0.31) | 10,365.50<br>(0.64) | 4,727.60<br>(1.42) | -934.06<br>(-7.27) |
| 6 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales or forward contracting. | 26,337.42<br>(0.26) | 16,548.36<br>(0.41) | 11,672.40<br>(0.59) | 6,777.88<br>(1.04) |

Table 5-7. Continued

| Risk-Management Scenario | Description of Risk-Management Scenario | Increase in the 1984 Total Irrigation Costs | | | |
|---|---|---|---|---|---|
| | | 0%[c] | 50% | 75% | 100% |
| 9 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and hedging. | 22,784.03<br>(0.34) | 11,460.69<br>(0.68) | 5,822.79<br>(1.35) | 161.13<br>(49.04) |
| 10 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest and hedging. | 27,518.97<br>(0.29) | 17,729.11<br>(0.45) | 12,853.14<br>(0.63) | 7,958.62<br>(1.03) |
| 13 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,133.84<br>(0.42) | 11,810.50<br>(0.83) | 6,172.60<br>(1.59) | 510.94<br>(19.26) |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 27,867.97<br>(0.36) | 18,078.92<br>(0.56) | 13,202.95<br>(0.77) | 8,308.43<br>(1.23) |

---

[a] The coefficient of variation defined as standard deviation divided by mean is listed in parenthesis.

[b] The typical North Florida farm modeled is a mixed crop farm growing four crops--corn, peanuts, soybeans and winter wheat with a size of 235 acres.

[c] This level is at the 1984 total irrigation cost level.

Table 5-8. Efficient Set of Risk-Management Scenarios for the Different Utility Groups of Farmers with Variation in the 1984 Total Irrigation Costs for the Typical Farm[a] in North Florida

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Increase in the 1984 Total Irrigation Costs | | | |
|---|---|---|---|---|---|
| | | 0%[b] | 50% | 75% | 100% |
| -0.00050 to -0.00001 | Moderate Risk Lover | 2 | 2,4 | 4 | 4 |
| -0.00001 to 0.00000 | Low Risk Lover | 2 | 2 | 4 | 4 |
| 0.00000 to 0.00000 | Risk Neutral (maximizers of expected profits) | 2 | 2 | 4 | 4 |
| 0.00000 to 0.00001 | Very Low Risk Averse | 2 | 2 | 4 | 4 |
| 0.00001 to 0.00003 | Low Risk Averse | 2 | 2 | 4 | 4 |
| 0.00003 to 0.00010 | Moderate Risk Averse | 2 | 2 | 4 | 4 |
| 0.00010 to 0.00050 | High Risk Averse | 2,6,10,14 | 2,4,6,8,10 12,14,16 | 2,4,6,8 10,12,16 | 4,8,12,16 |

Table 5-8. Continued

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Increase in the 1984 Total Irrigation Costs | | | |
|---|---|---|---|---|---|
| | | 0%[b] | 50% | 75% | 100% |
| 0.00050 to 0.00100 | Very High Risk Averse | 6 | 6 | 6,8 | 8 |
| 0.00000 to 0.00100 | Second Degree Stochastic Dominance | 2,6,10,14 | 2,6,10,14 | 2,4,6,8,<br>10,12,16 | 4,8,12,16 |
| -0.00100 to 0.00100 | First Degree Stochastic Dominance | 2,6,10,14 | 2,4,6,8,10<br>12,14,16 | 2,4,6,8,<br>10,12,16 | 4,8,12,16 |

[a] The typical North Florida farm model is a middle-sized mixed crop farm growing four crops--corn, peanuts, soybeans and wheat with a size of 235 acres.

[b] This level corresponds to the 1984 total irrigation costs.

risk-lovers, risk-neutral, very low risk-averse, low risk-averse and moderately risk-averse groups of farmers. However, with increase of irrigation costs of 50 percent or less, scenario 2--the most profitable irrigated scenario--dominates all risk-management scenarios for these same groups of farmers. The general conclusion that can be detected from these results is that irrigation reduces yield variability, income variability and increases income under existing market conditions (1984). Rapid increases of total irrigation costs (75 percent or more above existing level) with crop prices held constant, however, renders irrigation unprofitable as a risk-management practice.

The other finding from this analysis is that a 50 percent to 75 percent increase in the total costs of irrigation, the zone at which irrigation is marginally profitable, results in a relatively larger risk-efficient set for first and second degree stochastic dominance compared to zero percent or 100 percent increases in irrigation cost.

### Changes in the Peanuts Acreage or Allotment in the Base Model and Replacement with Other Crops

One of the key changes expected in the 1985 agricultural policy of the federal government is an increasing push for more market-oriented agriculture. Hence the peanuts program under which farmers are assigned an acreage allotment to grow the crop which can be marketed at guaranteed prices by the government may be modified or even eliminated. This study attempts to find the impact of cutting down the present acreage allotment by 50 percent and replacing the peanuts with one of the other three crops in the model--soybeans, winter wheat and corn--for which production is more market oriented in North Florida.

This analysis is a sample case to illustrate the importance of peanuts. More detailed analysis of the effects of the curtailment of the peanuts program is not done because of lack of knowledge of the federal government policies on the program at the time of the study.

The average or typical peanuts allotment acreage is currently about 30 acres. Fifteen acres or 50 percent of the allotment is now assumed to be taken out of peanuts production and replaced by either soybeans, winter wheat or corn by the same 15 acres to keep the model farm size at 235 acres.

Table 5-9 presents the mean incomes and the coefficient of variation of incomes of the various risk-management scenarios with substitution of 15 acres of peanut acreage by either corn, soybeans or winter wheat, given 1984 market conditions. The first obvious result is that the substitution of peanuts acreage leads to a substantial reduction in the mean income and also leads to an increase in the variability of incomes measured by the coefficient of variation of income. The increase in income variability is the result of substituting a crop that has a guaranteed stable price by crops whose prices are dependent more on market conditions.

Table 5-9 also indicates that soybeans are the best substitute crop for peanuts followed closely by corn with wheat a distant third. Soybeans replacing peanuts leads to the lowest reduction in the mean incomes for 12 out of the 16 risk-management scenarios. Replacing peanuts with corn leads to the lowest reduction in mean income in the other four scenarios. Taking scenario 2--the most profitable scenario--for specific analysis, it can be observed that the substitution of peanuts by soybeans leads to a decline in income of about

Table 5-9. Mean Income and the Coefficients of Variation of Income[a] for the Various Risk-Management Scenarios with Substitution of Acreage Allotment of Peanuts by Either Corn, Soybeans or Wheat in 1984 Dollars

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Level and Type of Peanuts Substitution for 15 Acres of Land Taken Out of Peanut Production | | | |
|---|---|---|---|---|---|
| | | No Substitution[b] | Increase of Wheat Acreage | Increase of Soybeans Acreage | Increase of Corn Acreage |
| 1 | Production--sands soils with irrigation. Marketing--cash sales at harvest time only. | 27,197.60<br>(0.43) | 20,572.15<br>(0.55) | 22,859.69<br>(0.55) | 22,732.24<br>(0.54) |
| 2 | Production--sandy-loam soils with irrigtion. Marketing--cash sales at harvest time only. | 31,931.37<br>(0.37) | 25,205.38<br>(0.46) | 27,532.10<br>(0.47) | 27,347.57<br>(0.45) |
| 3 | Production--sands soils with no irrigation. Marketing--cash sales at harvest time only. | 3,107.91<br>(3.78) | -778.34<br>(-14.18) | 85.96<br>(143.48) | -1,106.30<br>(-10.55) |

Table 5-9. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Level and Type of Peanuts Substitution for 15 Acres of Land Taken Out of Peanut Production | | | |
|---|---|---|---|---|---|
| | | No Substitution[b] | Increase of Wheat Acreage | Increase of Soybeans Acreage | Increase of Corn Acreage |
| 4 | Production--sandy-loam soils with no irrigation. Marketing--cash sales at harvest time only. | 17,956.70<br>(0.73) | 12,111.52<br>(1.04) | 13,649.56<br>(1.03) | 12,356.95<br>(1.07) |
| 5 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 21,688.84<br>(0.31) | 15,089.43<br>(0.42) | 16,841.72<br>(0.41) | 16,623.26<br>(0.41) |
| 6 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales or forward contracting. | 26,337.42<br>(0.26) | 19,640.65<br>(0.32) | 21,419.13<br>(0.32) | 21,143.65<br>(0.32) |
| 7 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 609.23<br>(17.55) | -3,250.98<br>(-3.05) | -2,676.76<br>(-4.13) | -3,830.07<br>(-2.75) |

Table 5-9. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Level and Type of Peanuts Substitution for 15 Acres of Land Taken Out of Peanut Production | | | |
|---|---|---|---|---|---|
| | | No Substitution[b] | Increase of Wheat Acreage | Increase of Soybeans Acreage | Increase of Corn Acreage |
| 8 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 14,708.87<br>(0.79) | 8,893.28<br>(1.24) | 10,062.25<br>(1.22) | 8,813.69<br>(1.32) |
| 9 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and hedging. | 22,784.03<br>(0.34) | 16,158.58<br>(0.47) | 17,232.61<br>(0.42) | 17,656.50<br>(0.45) |
| 10 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest and hedging. | 27,518.17<br>(0.29) | 20,791.81<br>(0.37) | 21,905.01<br>(0.34) | 22,271.83<br>(0.37) |

Table 5-9. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Level and Type of Peanuts Substitution for 15 Acres of Land Taken Out of Peanut Production | | | |
|---|---|---|---|---|---|
| | | No Substitution$^b$ | Increase of Wheat Acreage | Increase of Soybeans Acreage | Increase of Corn Acreage |
| 11 | Production--sands soils without irrigation. Marketing--mix of cash sales at harvest and hedging. | 1,232.21<br>(8.88) | 2,654.04<br>(-3.84) | -1,789.74<br>(-6.39) | -2,982.00<br>(3.63) |
| 12 | Production--sandy-loam soils without irrigation. Marketing--mix of cash sales at harvest and hedging. | 16,081.00<br>(0.76) | 10,235.82<br>(1.13) | 10,560.34<br>(1.17) | 9,819.08<br>(1.24) |
| 13 | Production--sands soils without irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,133.84<br>(0.42) | 16,508.39<br>(0.58) | 17,583.31<br>(0.57) | 18,122.32<br>(0.57) |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 27,867.97<br>(0.36) | 21,141.62<br>(0.46) | 22,255.71<br>(0.46) | 22,737.65<br>(0.46) |

Table 5-9. Continued

| Risk-Management Scenario Number | Description of Risk-Management Scenarios | Level and Type of Peanuts Substitution for 15 Acres of Land Taken Out of Peanut Production | | | |
|---|---|---|---|---|---|
| | | No Substitution[b] | Increase of Wheat Acreage | Increase of Soybeans Acreage | Increase of Corn Acreage |
| 15 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 1,349.11<br>(8.36) | -2,537.14<br>(-4.15) | -1,672.84<br>(-7.06) | -2,865.10<br>(-3.90) |
| 16 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 16,197.90<br>(0.78) | 10,352.72<br>(1.16) | 10,678.13<br>(1.23) | 10,051.99<br>(1.26) |

---

[a] The coefficient of variation of income is in parenthesis.

[b] No substitution denotes that the acreage devoted to peanuts is kept at 30 acres as is in the base model.

$4,339 or about 13.6 percent. The reductions in income for using corn and wheat as the replacement crop are $4,584 (14.3 percent) and $6,726 (21.1 percent), respectively.

Recall that in Chapter 4, peanuts production as the dominant or major crop is regarded as one of the key factors responsible for farmers' non-use of certain risk-management responses. The guaranteed relatively high support price for peanuts by the federal government acts as a form of support system for farmers growing the crop thus probably reducing their risk aversion. The results from Table 5-9 indicate that elimination or the substantial reduction of the peanuts program will lead to higher income variability, the use of more risk-management responses and also reduction in income at least in the short run.

The risk-efficient set of management scenarios, however, remains unchanged from that of the base model. Also, the type of crop used as the substitute crop does not affect the size and composition of the risk-efficient set of scenarios or farm plans. The peanuts substitution only leads to an income reduction which affects all the scenarios in a similar manner.

### Variation in the Amounts of Corn and Soybeans Sold in the Futures Market Either through Hedging or Futures Options

The amounts of corn and soybeans sold under the futures market arrangements in the base model are between 27 percent to 43 percent of the 17 years average yields and vary because of the type of soil and whether irrigation is used or not. Also, the amounts traded are rounded off to the nearest thousands of bushels. These amounts traded in the base model are regarded as the average participation by the farmer in the futures markets trading. Futures market trading, as expressed by percentages of the 17 years average yields traded in the futures market, vary between 69 and 92 percent depending on type of soil, whether crops are irrigated and the fact the amounts are rounded up to the nearest thousands of bushels.

Table 5-10 presents the mean income, and the coefficient of variation of income for the various risk-management scenarios for both the average and the high rate of futures market participation by the farmer. The scenarios of concern are scenarios 9 to 16 since they are the scenarios for which the futures market (either hedging or futures options) is used`as a marketing strategy.

Comparing the incomes under average and high usage of futures market indicates that high usage of the futures markets leads to lower mean incomes than average usage. One reason for the substantial decline in incomes is that for the high amounts of crops traded in the futures markets, the amounts contracted may exceed the actual total production in bad weather years, especially for the non-irrigated scenarios--11 and 15. For the irrigated scenarios, when the farmer hedges, the decline in incomes from average to high level of participation is the same for both sands and sandy-loam soils. The same results holds when the farmer sells his crops under the futures option marketing arrangements.

Table 5-11 represents the risk-efficient set of the management scenarios according to the different groups of farmers and the degree of usage of the futures markets. The results indicate that the risk-efficient set of scenarios remain the same for both the average and

Table 5-10. Mean Income in Dollars and the Coefficient of Variation of Income for the Various Risk-Management Scenarios with Changes in the Degree of Usage of the Futures Markets for the Typical North Florida Farm under 1984 Conditions

| Risk-Management Scenario | Description of Risk-Management Scenarios | Degree of Usage of the Futures Market | | | | Decline in Mean Income from Switching from Average to High Usage of the Futures Market |
|---|---|---|---|---|---|---|
| | | Average[a] | | High[b] | | |
| | | Mean | C.V. | Mean | C.V. | |
| 9 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and hedging. | 22,784.03 | 0.34 | 17,819.12 | 0.26 | 4,964.91 |
| 10 | Production--sandy-loam soils with irrigation. Marketing--cash sales at harvest and hedging. | 27,518.17 | 0.29 | 22,553.25 | 0.21 | 4,964.92 |
| 11 | Production--sands soils without irrigation. Marketing--mix of cash sales at harvest and hedging. | 1,232.21 | 8.88 | -643.48 | -16.26 | 1,875.69 |

Table 5-10. Continued

| Risk-Management Scenario | Description of Risk-Management Scenarios | Degree of Usage of the Futures Market | | | | Decline in Mean Income from Switching from Average to High Usage of the Futures Market |
|---|---|---|---|---|---|---|
| | | Average[a] | | High[b] | | |
| | | Mean | C.V. | Mean | C.V. | |
| 12 | Production--sandy-loam without irrigation. Marketing--mix of cash sales at harvest and hedging. | 16,081.00 | 0.76 | 12,329.61 | 0.90 | 3,751.39 |
| 13 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,133.84 | 0.42 | 18,403.61 | 0.44 | 4,730.21 |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 27,867.97 | 0.36 | 23,137.75 | 0.37 | 4,730.22 |

Table 5-10. Continued

| Risk-Management Scenario | Description of Risk-Management Scenarios | Degree of Usage of the Futures Market | | | | Decline in Mean Income from Switching from Average to High Usage of the Futures Market |
|---|---|---|---|---|---|---|
| | | Average[a] | | High[b] | | |
| | | Mean | C.V. | Mean | C.V. | |
| 15 | Production--sandy-loam soils without irrigation. Marketing--mix of cash sales at harvest and futures options. | 1,349.11 | 8.36 | -409.68 | -26.69 | 1,758.79 |
| 16 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 16,197.90 | 0.78 | 12,680.31 | 0.94 | 3,517.59 |

---

[a] The average level of usage of the futures market corresponds to the level in the base model. The amounts of corn and soybeans hedged or sold under options for the different production strategies are as follows in bushels for the typical farm, respectively: I. Sands soils with irrigation--3,000, 2,000; II. Sandy-loam soils with irrigation--3,000, 2,000; III. Sands soils without irrigation--1,000, 1,000; IV. Sandy-loam soils without irrigation--1,000; 1,000.

[b] The amounts of corn and soybeans hedged or sold under futures options for the high participation in the futures market are listed as follows in bushels, respectively: I. Sands soils with irrigation--5,000, 5,000; II. Sandy-loam soils with irrigation--5,000, 5,000; III. Sands soils without irrigation--2,000, 2,000; IV. Sandy-loam soils without irrigation--3,000, 3,000.

Table 5-11. Efficient Set of Risk-Management Scenarios According to the Utility Groups of Farmers and the Level of Usage of Futures Market for the Typical Farm in North Florida under 1984 Conditions

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Degree or Level of Usage of Futures Market by Farmer | |
|---|---|---|---|
| | | Average[a] | High[b] |
| -0.00050 to -0.00001 | Moderate Risk Lover | 2 | 2 |
| -0.00001 to 0.00000 | Low Risk Lover | 2 | 2 |
| 0.00000 to 0.00000 | Risk Neutral (maximizers of expected profits) | 2 | 2 |
| 0.00000 to 0.00001 | Very High Risk Averse | 2 | 2 |
| 0.00001 to 0.00003 | Low Risk Averse | 2 | 2 |
| 0.00003 to 0.00010 | Moderate Risk Averse | 2 | 2 |
| 0.00010 to 0.00050 | High Risk Averse | 2,6,10,14 | 2,6,10,14 |
| 0.00050 to 0.00100 | Very High Risk Averse | 6 | 10 |

Table 5-11. Continued

| Utility Groups (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Degree or Level of Usage of Futures Market by Farmer | |
|---|---|---|---|
| | | Average[a] | High[b] |
| 0.00000 to 0.00100 | Second Degree Stochastic Dominance | 2,6,10,14 | 2,6,10,14 |
| -0.00100 to 0.00100 | First Degree Stochastic Dominance | 2,6,10,14 | 2,6,10,14 |

[a] The average level of usage of the futures market corresponds to the level in the base model. The amounts of corn and soybeans hedged or sold under options for the different production strategies are as follows in bushels for the typical farm, respectively:

I. Sands soils with irrigation--3,000, 2,000;
II. Sandy-loam soils with irrigation--3,000, 2,000;
III. Sands soils without irrigation--1,000, 1,000;
IV. Sandy-loam soils without irrigation--1,000, 1,000.

[b] The amounts of corn and soybeans hedged or sold under futures options for the high participation in the futures market are listed as follows in bushels, respectively:

I. Sands soils with irrigation--5,000, 5,000;
II. Sandy-loam soils with irrigation--5,000, 5,000;
III. Sands soils without irrigation--2,000, 2,000;
IV. Sandy-loam soils without irrigation--3,000, 3,000.

high levels with one exception. For the very high risk-averse groups of farmers, scenario 10 dominates all the other scenarios for the high usage of the futures markets in contrast to scenario 6 under the average usage. The explanation of this exception may be due to the very high risk-averse farmer trying to maintain stability of income through the reduction of income variability. Thus, more use of hedging (scenario 10) offers him a chance to reduce price variability.

## Variation in the Amounts of Crops Forward-Contracted

In the base model, 50 percent of the 17 years average yields of the four crops are forward contracted. The rest of the crops are sold for cash at harvest times. Further analysis is done by changing the percentages of the average yields contracted from 50 percent to 25 percent and 75 percent.

Table 5-12 reports the mean incomes and the coefficient of variation of income for the various risk-management scenarios with changes in the amounts of the four crops forward contracted. The results show that for the four risk-management scenarios involving forward contracting (scenarios 5, 6, 7 and 8), there is a decline in the mean incomes with increasing percentages of the average yields forward contracted.

Table 5-13 reports the risk-efficient set of management scenarios for the different groups of farmers with variation in the amounts of the four crops forward contracted. These results show that the risk-efficient set remains the same across all the three levels of amounts of forward contracting except for the very high risk-averse group of farmers. Recall that the very high risk-averse group of farmers are

Table 5-12. Mean Income in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in the Level of Amounts of Four Crops Forward Contracted for the Typical Farm in North Florida under 1984 Conditions

| Risk-Management Scenario[a] | Description of Risk-Management Scenario | Percentage of Amount of Harvested Crops Forward Contracted as a Fraction of 17 Years Average Yields | | |
|---|---|---|---|---|
| | | 25% | 50%[b] | 75% |
| 5 | Production--sands soils with irrigation. Marketing--mix of cash at harvest and forward contracting. | 24,443.22<br>(0.37) | 21,688.84<br>(0.31) | 18,934.47<br>(0.25) |
| 6 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 29,134.57<br>(0.32) | 26,337.42<br>(0.26) | 23,540.27<br>(0.20) |
| 7 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 1,858.57<br>(6.00) | 609.23<br>(17.55) | -640.11<br>(-16.23) |
| 8 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and forward contracting. | 16,332.81<br>(0.75) | 14,708.87<br>(0.79) | 13,085.04<br>(0.80) |

---

[a] Scenarios 5-8 are those scenarios involving the forward contracted marketing strategy.

[b] This level corresponds to the amounts forward contracted in the base or initial model.

Table 5-13. Efficient Set of Risk-Management Scenarios for the Different Utility Groups of Farmers with Variation in the Level or Amounts of the Four Crops Forward Contracted for the Typical Farm in North Florida under 1984 Conditions

| Utility Groups of Farmers (Lower and Upper Bound of Risk-Aversion Coefficient) | Description of Members of the Group | Fraction of the 17 Years Average Yields That Is Forward Contracted | | |
|---|---|---|---|---|
| | | 25% | 50%[a] | 75% |
| -0.00050 to -0.00001 | Moderate Risk Lover | 2 | 2 | 2 |
| -0.00001 to 0.00000 | Low Risk Lover | 2 | 2 | 2 |
| 0.00000 to 0.00000 | Risk Neutral (maximizers of expected profits) | 2 | 2 | 2 |
| 0.00000 to 0.00001 | Very Low Risk Averse | 2 | 2 | 2 |
| 0.00001 to 0.00003 | Low Risk Averse | 2 | 2 | 2 |
| 0.00003 to 0.00010 | Moderate Risk Averse | 2 | 2 | 2 |
| 0.00010 to 0.00050 | High Risk Averse | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |
| 0.00050 to 0.00100 | Very High Risk Averse | 10 | 6 | 6 |
| 0.00000 to 0.00100 | Second Degree Stochastic Dominance | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |
| -0.00100 to 0.00100 | First Degree Stochastic Dominance | 2,6,10,14 | 2,6,10,14 | 2,6,10,14 |

[a] This level corresponds to the amounts forward contracted in the base or the initial model.

most concerned with income stability and hence reduction of income variability. For the 25 percent level of forward contracting, scenario 10 (the most profitable hedging scenario) dominates all the other scenarios considered while scenario 6 (a scenario involving forward contracting) dominates all other considered scenarios for the 50 percent and 75 percent levels of forward contracting. This difference of choice by the very high risk-averse group of farmers can be explained by their concern with income stability. At the 25 percent level of forward contracting, it means that 75 percent of the crops produced are sold for cash at harvest times. However, even though cash sales yield the highest average income among the four marketing strategies, it also yields the highest income variability. The 25 percent level of forward contracting hence does not offer the very high risk-averse farmer the degree of income stability that he wants and, therefore, he chooses scenario 10 (which involves hedging in the futures market).

However, as the level of or percentage of forward contracting increases to 50 percent and 75 percent, scenario 6--the most profitable forward contracting scenario--dominates all other risk-management scenarios for the very high risk-averse farmers.

### Variation in the Premium and Strike Price under the Futures Options Marketing Strategy

In the base model, the strike price or the exercise price for which the farmer can sell crops is set at the prevailing planting time futures price for the crop (1984) and the corresponding premium is calculated using the Agnet options program described in Chapter 3.

Recall that the theoretical premiums and actual premiums under the futures options have been found to be very highly correlated at a level of 0.948 (Chapter 3).

In this section, the analysis concentrates on varying the strike price $0.25 and $0.50 above and below the original strike price in the base model. The original strike price is roughly the planting time futures price of the crop. The corresponding premiums are calculated and used to derive the mean incomes, coefficient of variation of income and the risk-efficiency comparisons of the 16 risk-management scenarios or farm plans. The analysis is done separately for corn and soybeans.

Tables 5-14 and 5-15 report the mean incomes and the coefficient of variation of income for the various risk-management scenarios with the changes in strike prices and premiums for corn and soybeans, repsectively. The scenarios to be considered are scenarios 13, 14, 15 and 16 since these are the scenarios involving use of the futures options marketing strategy.

From Tables 5-14 and 5-15, it is apparent that the mean incomes and coefficient of variation of incomes are virtually identical across all strike prices and premiums. The differences in mean incomes for the scenarios 13 to 16 are minor and the risk-efficient set of management scenarios for the different groups of farmers remains the same across all strike prices and premiums.

The results from Tables 5-14 and 5-15 clearly indicate that the futures option market is working extremely well such that the premium fee assigned to the specific strike price makes the prospective participant or farmer indifferent to the choice of strike prices. Whatever level of strike price that is chosen by the prospective

Table 5-14. Mean Incomes in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in Premium and Strike Prices for the Futures Put Options for Corn under 1984 Conditions

| Risk-Management Scenario | Description of Risk-Management Scenario | Strike Prices and Premiums for the Corn Crop in Dollars | | | | |
|---|---|---|---|---|---|---|
| | | 2.50<br>(0.00) | 2.75<br>(0.02) | 3.00[a]<br>(0.08) | 3.25<br>(0.19) | 3.50<br>(0.37) |
| 13 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,083.92<br>(0.43)[b] | 23,108.30<br>(0.43) | 23,133.84<br>(0.42) | 23,148.86<br>(0.41) | 23,071.56<br>(0.40) |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 27,818.05<br>(0.37) | 27,842.44<br>(0.37) | 27,867.97<br>(0.36) | 27,883.00<br>(0.35) | 27,805.70<br>(0.34) |
| 15 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 1,332.47<br>(8.49) | 1,340.60<br>(8.43) | 1,349.11<br>(8.36) | 1,354.12<br>(8.30) | 1,328.35<br>(8.45) |

Table 5-14. Continued

| Risk-Management Scenario | Description of Risk-Management Scenario | Strike Prices and Premiums for the Corn Crop in Dollars | | | | |
|---|---|---|---|---|---|---|
| | | 2.50<br>(0.00) | 2.75<br>(0.02) | 3.00[a]<br>(0.08) | 3.25<br>(0.19) | 3.50<br>(0.37) |
| 16 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 16,181.26<br>(0.78)[b] | 16,189.39<br>(0.78) | 16,197.90<br>(0.78) | 16,202.90<br>(0.78) | 16,177.14<br>(0.78) |

[a] Strike price used in the base model.

[b] The coefficients of variation of income are in parentheses.

Table 5-15. Mean Incomes in Dollars and the Coefficient of Variation of Incomes for the Various Risk-Management Scenarios with Changes in Premium and Strike Prices for the Marketing Options for Soybeans under 1984 Conditions

| Risk-Management Scenario | Description of Risk-Management Scenario | Strike Prices and Premiums for the Soybeans in Dollars | | | | |
|---|---|---|---|---|---|---|
| | | 7.00<br>(0.43) | 7.25<br>(0.54) | 7.50[a]<br>(0.66) | 7.75<br>(0.80) | 8.00<br>(0.95) |
| 13 | Production--sands soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 23,205.71<br>(0.43)[b] | 23,205.84<br>(0.43) | 23,133.84<br>(0.42) | 23,082.24<br>(0.41) | 23,110.67<br>(0.41) |
| 14 | Production--sandy-loam soils with irrigation. Marketing--mix of cash sales at harvest and futures options. | 28,018.85<br>(0.37) | 27,939.97<br>(0.36) | 27,867.97<br>(0.36) | 27,816.37<br>(0.35) | 27,844.80<br>(0.35) |
| 15 | Production--sands soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 1,424.55<br>(7.97) | 1,385.11<br>(8.16) | 1,349.11<br>(8.36) | 1,323.31<br>(8.50) | 1,337.53<br>(8.38) |

Table 5-15. Continued

| Risk-Management Scenario | Description of Risk-Management Scenario | Strike Prices and Premiums for the Soybeans in Dollars | | | | |
|---|---|---|---|---|---|---|
| | | 7.00<br>(0.43) | 7.25<br>(0.54) | 7.50[a]<br>(0.66) | 7.75<br>(0.80) | 8.00<br>(0.95) |
| 16 | Production--sandy-loam soils with no irrigation. Marketing--mix of cash sales at harvest and futures options. | 16,273.33<br>(0.78)[b] | 16,233.90<br>(0.78) | 16,197.90<br>(0.78) | 16,172.10<br>(0.78) | 16,186.31<br>(0.78) |

[a] Strike price used in the base model.

[b] The coefficients of variation of income are in parentheses.

farmer, the premium charged makes the mean incomes and the coefficient of variation of income generated virtually the same. Hence, the key factor for the farmer to decide whether to buy futures options should be to compare the incomes and the income variability obtained from future options with the other marketing strategies such as forward contracting, hedging and cash sales at harvest as is done in the earlier sections of this chapter. The level of strike price and the corresponding premium are not relevant to the decision whether to buy the options or not, at least under market conditions at the time of the study.

# CHAPTER 6
# CONCLUSIONS AND RECOMMENDATIONS

The study consists of two parts. The first part is concerned with a survey of sample farmers in North Florida and South Alabama to determine farmers' perceptions of the relative importance of sources of risk and management responses towards risk. The second part involves the stochastic modeling analysis of various risk-management scenarios or farm plans for a typical middle-sized, mixed crop farm in North Florida using stochastic dominance analysis to establish risk-efficient plans for different groups of farmers classified according to their risk attitudes.

The risk survey results shed valuable light on farmers perceptions of risk, risk sources and management responses towards risk. The farmers generally tend to define risk in terms of the potential or the probability of negative or adverse outcomes. Despite a relatively diverse sample in terms of education, experience, farm size, leverage ratio and farm income there is considerable consensus on the relative importance of various sources of risk and alternative risk management practices. Less than half of the various of sources of risk in crops and livestock production and less than one-third of the responses on the use of risk-management practices have significant relationships with one or more of the any of four key socioeconomic variables. These variables are the leverage ratio, size of farm, experience in farming and the production of peanuts as the dominant crop.

Production risks (rainfall variability, diseases and pests) are identified as the most important category of crop risks, followed by market risks (variability in commodity prices, inflation and variability in the costs of operating inputs). Financial risks which involve the cost of credit, availability of loan funds and the use of leverage follow market risks in order of importance for crop risks. In general, livestock risks are ranked as less important than crop risks. However, four livestock risk sources--livestock products prices, weather variability, diseases and pests, and costs of operating inputs--are considered very important.

Logistic regression techniques are used to investigate the effect of various socioeconomic characteristics of the farmers on the probability that they use a particular risk management practice. The farm's leverage ratio, size, the production of peanuts as the dominant crop and the producer's experience are the four most important variables in determining use versus non-use of certain risk-management practices. Peanuts are the most important crop grown by about two-thirds of the sample farmers. With the guaranteed relatively higher price for the crop by the federal government for those farmers with allotment acreage, it is not surprising that farmers growing peanuts as the major crop, use less of certain risk-management strategies, for example, government-financed loans than those growing other crops as the major crop. Increasing experience in farming and lower leverage ratio of the farm also lead to the declining use of several risk-management strategies. Larger farms are more likely to maintain financial reserves, but less likely to undertake off-farm employment than smaller farms.

The survey analysis seems to identify two groups of producers. One group consists of the older, more experienced, established farmers. These farmers tend to have smaller acreages and lower leverage ratios and though not highly profitable, they are more financially secure. The second group consists of younger, more aggressive farmers. These farmers tend to have larger acreages and higher leverage ratios resulting in more tenuous financial positions.

The stochastic modeling analysis of various risk-management scenarios or farm plans for the typical farm forms the second part of the study. The results indicate that farmers behave differently in their choice of farm plans according to their risk attitudes. For the low risk-averse farmers, for example, cash sales at harvest time only of the crops produced is the most preferred marketing strategy, while a mixture of cash sales at harvest time and forward contracting is the most preferred for very high risk-averse farmers. A special group of farmers modeled in this study is the risk-neutral farmers. These farmers are classified as those that maximize expected profits and their behavior is consistent with the conclusions derived from the neo-classical theory of the farm-firm. In this study, the risk-neutral farmers' behavior is different from the high and very high risk-averse farmers. Their behavior is identical to that of the risk lovers and low risk-averse farmers. The risk survey of farmers indicate that about 75 percent of the farmers use some forward contracting and this result seems to indicate that these farmers are then highly risk averse. This result raises a question as to the validity of economic models based solely on expected profits maximization to describe the behavior of North Florida farmers.

The survey results also raise a question about why farmers rarely use the futures market and hence the economic viability of the futures market strategies such as hedging and futures options compared with popularly used marketing tools such as cash sales at harvest time and forward contracting. The stochastic dominance analysis of the various farm plans indicate that hedging and the futures options lead to higher incomes but also higher variability of income (risk) than forward contracting. However, they yield lower incomes and lower variability of incomes than the cash sales at harvest time marketing strategy. The futures markets trading strategies seem to lie in the middle between forward contracting and cash sales at harvest in terms of risk and income potential.

The futures options marketing strategy, which has just been recently introduced at the Chicago Board of Trade, is analyzed in more detail as to its economic viability. The results indicate that the level of the strike price and the corresponding premium are not relevant to the decision of whether the farmer should buy options or not, at least under current market conditions in North Florida. Rather, the farmer should compare the incomes and income variability (risk) from the options with other marketing strategies, such as hedging, forward contracting and cash sales at harvest time. For the four marketing strategies evaluated in the study--forward contracting, hedging, futures options and cash sales at harvest time--the futures options yield both the highest income and risk (income variability) after cash sales at harvest time strategy. The farmer using the futures market may increase farm income by trading part of the corn produced through the futures options and then hedging part of the soybeans crop--a combination of the two futures marketing strategies.

Other results of the stochastic modeling analysis of the farm plans indicate that substitution of peanuts by either soybeans, corn or wheat leads to significant loss of income and also to higher variability of income or risk. This result corroborates the findings from the farm risk survey of farmers which indicate that production of peanuts as the major or dominant crop leads to the reduction in the use of certain risk reducing management strategies, for example, government-financed credit schemes such as the Farmers' Home Administration loans. A possible casualty of the intended move of the federal government towards more free-market policies in agriculture may be the peanut program. Both the risk survey results and stochastic modeling analysis seem to confirm that, at least in the short run, a drastic curtailment of the peanuts program may hurt many farmers in North Florida and probably force them either out of business or to rely on other government programs such as Farmers Home Administration loans for survival.

The stochastic modeling analysis also indicates the viability of irrigation as a management practice under current economic conditions. Irrigation helps reduce both yield and income variability and also ensures higher income especially on the relatively infertile sandy soils which have low water holding capacity. However, the study shows also that if current irrigation costs are increased by 75 percent with crop prices remaining constant at their current levels, irrigation will be rendered unprofitable.

Finally, the sample size or the number of Monte Carlo replications used to establish the cumulative probability distribution of income affects the risk-efficient set of management scenario for different groups of farmers. The chances of correct rankings increase with larger sample sizes. This result appears to indicate that the arbitrary selection of say 100 as the number of replications in stochastic dominance modeling analysis may lead to biased results and conclusions.

## Policy Implications of the Study

Several implications may be drawn from the entire study. First of all, the survey results show that the farmers are clearly able to rank the relative importance of various sources of risk and management responses towards risk. This information provides a strong empirical basis for targeting reserach and extension programs in the area. Since it is demonstrated that rainfall variability and commodity prices variability are priority sources of risk of concern to the farmers, it becomes more justifiable to commit scarce resources to studying these problems.

Secondly, the study indicates that size of farm, producer's experience, leverage ratio and the production of peanuts as the dominant crop are key socioeconomic factors influencing the use of certain risk-management responses. Hence, these factors are important to consider in designing research and extension programs for farmers.

The key role played by the production of peanuts as the dominant crop in maintaining income stability is strongly emphasized. The production of peanuts leads to less use of several risk-management responses, including those involving other government programs. Hence the elimination or the severe curtailment of the federal government peanuts program is likely to lead to more financial difficulties and income instability for farmers. With agriculture being the backbone of the economy of North Florida and peanuts the major commodity produced, the elimination of the peanuts program may raise new social equity concerns, including the possibility of much higher bankruptcies of farms and unemployment in the area. The State of Florida may have to establish some subsidy programs or improvise some form of the federal government programs at least in the short to medium term. These programs may help the farmers to adjust to the unstable economic environment that might be created by the possible elimination of the present peanuts program. The Florida Department of Agriculture may need to undertake an exploratory study to evaluate the feasibility of such a state-sponsored program.

## Limitations of the Study

Because of the relatively small sample size of farmers used in the survey, the effect of certain important socioeconomic characteristics of farmers such as their educational level and race on the use of risk management responses cannot be ascertained. The small sample size also reduces the confidence that can be attached to the general conclusions derived from the survey analysis.

The stochastic modeling analysis of the typical farm focuses only on the production of crops. However, majority of the farmers in North Florida produce both crops and livestock. The exclusion of livestock production in the analysis means that the interrelationships between crops and livestock production and marketing decisions has not been evaluated.

## Suggestions for Further Research

The collection and retrieval of prices data for this study was one of the most burdensome aspects of this research project. This situation has been created partly by the abandonment of the United States Department of Agriculture (USDA) and the Florida Crop and Livestock Reporting Service from collecting monthly price data for crops in Florida since 1970.

It is proposed that the Department of Food and Resource Economics, University of Florida, through its research and extension wings start collecting daily, weekly or monthly prices of all the crop and livestock products not covered by the USDA (in order to speed up future research projects). As a starting point, all the prices collected for this study are reported in the appendices of this dissertation in case they may be useful for some future projects.

A study is also needed to be undertaken in Florida to determine the utility functions and the absolute risk-aversion coefficients of farmers. Since stochastic dominance theorems are now widely applied in agricultural economic analysis, it is important to determine the absolute risk-aversion coefficients of Florida farmers rather than relying on secondary data from other states as is done in this study.

Modeling of marketing decisions by buying agencies and elevators such as Goldkist company is an area that needs to be researched. The relationship between forward contract prices and futures prices of planting time, for example, is probably a key determinant to explain how the buying agencies set their forward contract prices for farmers. A simple regression equation between forward contract prices and futures prices may be useful to determine any linkage between the two sets of prices. This analysis could not be undertaken in this study because of the lack of price data especially past forward contract prices (from 1980 and beyond) in the study area.

The relationship between the sample size used to establish the cumulative probability distribution of income and risk-efficiency rankings of management scenarios needs to be studied further. This study raises an issue concerning the optimum sample size. Future studies may offer insight to this issue.

# APPENDICES

# APPENDIX A
# THE 1983 FARM RISK SURVEY QUESTIONNAIRE

## Risk Survey Questionnaire

## Confidential

State: ______________________ Questionnaire No. ______

Respondent:

Name ________________________________________

Address ______________________________________

______________________________________

______________________________________

County ____________________ Phone ______________

Enumerator ________________________________________

# FARMERS' ATTITUDES, PERCEPTIONS AND MANAGEMENT RESPONSES TO RISK

## IA. General Information about the Farm

Please complete or check the correct response.

1. Size of farm (normal year)

   a. Acres owned ______; Acres cash rented ______;

   Acres share leased ______.

   b. Acres presently under crops and/or harvestable forage ______.

   c. Acres in pasture or range _______.

2. Primary crops (please list in order of size).

| | Crop | Acres (in normal year) | Acres of double-cropping following this crop |
|---|---|---|---|
| a. | | | |
| b. | | | |
| c. | | | |
| d. | | | |
| e. | | | |
| f. | | | |
| g. | | | |

3. Cow-calf enterprise

   a. Number of cows in the herd __________.

   b. Number of cows replaced annually __________.

   c. Number of bulls __________.

   d. Calving season beginning date __________;

   ending date __________.

   e. Number of calves sold per year __________.

   f. Average weight of calves sold __________.

4. Other livestock enterprises (please list in order of importance). For breeding livestock, indicate the average number of head on hand at one time.

   For feeder livestock, indicate total yearly production in head and one time capacity of facilities.

| | Type of livestock | Size of enterprise |
|---|---|---|
| a. | ______ | ______ |
| b. | ______ | ______ |
| c. | ______ | ______ |
| d. | ______ | ______ |
| e. | ______ | ______ |
| f. | ______ | ______ |

5. Form of business organization.

   Individual proprietorship ______; Family partnership ______;

   Other partnership ______; "S" corporation ______;

   Regular corporation ______; Other or combination ______.

   Indicate combination ______.

IB. Relative importance of sources of farm risk.

Agriculture is characterized by risks. As a farmer in general, how would you define risk?

______

______

______

______

______

______

Do you believe that there is much risk in farming?

Yes ______ No ______

## IIA. RISK/VARIABILITY IN CROP PRODUCTION

(Please circle the number representing the importance
TO YOU of each source.)

| | Extremely Important | Moderately Important | | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | 0 |
| A. Rain variability (drought, flooding, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| B. Freezes | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| C. Other climatic factors (wind, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| D. Diseases and pests (weeds, diseases, insects, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| E. Commodity prices (changes in prices received due to supply and demand factors) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| F. Costs of operating inputs (fluctuating prices for seed, chemicals, fertilizers, fuel, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| G. Costs of capital equipment (unexpected variation in machinery and land prices | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| H. Availablity of loan funds (unexpected variation in availability of funds from lending institutions) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| I. Cost of credit (unexpected variation in interest rates) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| J. Use of leverage (unexpected changes in vulnerability of cash flows and credit worthiness due to high leverage) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| K. Leasing (unexpected changes in availability on terms of leasing farmland) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| L. Changes in technology (development of new capital items that make existing obsolete and of reduced value, e.g., new harvester) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| M. Government commodity programs (changes in target prices, loan levels eligibility requirements) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| N. Federal and state government laws and regulations (changes in tax laws, environmental regulations, labor regulations, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| O. Inflation (unexpected changes in prices, costs and investment returns) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| P. World economic situation (unexpected world events which affect your farm) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| Q. Personal safety and health (accidents, family illnesses) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| R. Family plans (changes in family situation, family goals, inheritance, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| S. Hired labor (unexpected changes associated with hired labor) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| T. Theft (farm equipment, crops, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| U. Other (please indicate sources of variation) | 5 | 4 | 3 | 2 | 1 | 0 |
| ____________________ | 5 | 4 | 3 | 2 | 1 | 0 |
| ____________________ | 5 | 4 | 3 | 2 | 1 | 0 |
| ____________________ | 5 | 4 | 3 | 2 | 1 | 0 |

## IIB. RISK/VARIABILITY IN LIVESTOCK PRODUCTION

(Please circle the number representing the importance TO YOU of each source.)

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | 0 |
| A. Weather variability (heat, cold, climatic conditions affecting feed supplies, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| B. Diseases and pests animal diseases, insects, parasites, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

| | | | | | | |
|---|---|---|---|---|---|---|
| C. Livestock and product prices (changes in prices received due to supply and demand factors) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

______________________________________________

______________________________________________

______________________________________________

| | | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|---|
| D. | Costs of operating inputs (fluctuating prices for pasture, feed, feeder livestock, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E. | Costs of capital equipment (unexpected variation in costs of livestock facilities, breeding stock, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| F. | Availability of loan funds (unexpected variation in availability of funds from lending institutions) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| G. Cost of credit (unexpected variation in interest rates) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| H. Use of leverage (unexpected changes in vulnerability of cash flows and credit worthiness due to high leverage) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| I. Leasing (unexpected change in availability or terms of leasing land) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| J. Changes in technology (development of new capital items that make existing capital obsolete and of reduced value, e.g., confinement buildings) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| K. Government agricultural programs (unexpected changes in government programs affecting livestock producers, e.g., dairy program, public land, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| L. Federal and state government laws and regulations (changes in tax laws, environmental regulations, feed additives, labor regulations, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| M. Inflation (unexpected changes in prices, costs and investment returns) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| N. World economic situation (unexpected world events which affect your farm) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| O. Personal safety and health (accidents, family illiness) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | Extremely Important | | Moderately Important | | Not Important | Does Not Apply |
|---|---|---|---|---|---|---|
| P. Family plans (unexpected changes in family situation, family goals, inheritance, etc.) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| Q. Hired labor (unexpected changes associated with hired labor) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| R. Theft (equipment and livestock) | 5 | 4 | 3 | 2 | 1 | 0 |

Describe what, if any, actions YOU take to combat this source of risk.

| | | | | | | |
|---|---|---|---|---|---|---|
| S. Other sources of variability or risk | 5 | 4 | 3 | 2 | 1 | 0 |
| | 5 | 4 | 3 | 2 | 1 | 0 |
| | 5 | 4 | 3 | 2 | 1 | 0 |
| | 5 | 4 | 3 | 2 | 1 | 0 |

## III. Management Responses to Risk/Variability

This part of the survey lists a number of responses or methods which some farmers use to deal with variability. First, please indicate the relative importance of these methods for dealing with the variability on your farm. If a method is extremely important to you, circle the "very important." If the method does not apply to the variability you face, circle the "does not apply."

Second, please indicate whether you use this method or response in your farm operation to deal with variability. If you do use a response, please add some brief comments to describe how you use it. Sometimes you may use a response for a reason other than variability. If there are other reasons important to your decision, please indicate this too.

1. Enterprise diversification: production of more than one enterprise to spread risks and stabilize total returns.

   a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

   b. Do you use this method? No ______ Yes ______

   If you use this method, please provide a brief description of how you use it.

   ______________________________________________

   ______________________________________________

   ______________________________________________

2. Geographic diversification: operation of farm units over a wide geographic area to spread risks and stabilize returns.

   a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

3. Production practice diversification: use of multiple varieties combinations of herbicides, use of fertilizers in different forms, etc., to spread risks and stabilize returns.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

4. Maintaining feed reserves: use of physical reserves of feed to offset drought or other unfavorable weather conditions.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

5. Spreading sales: use of frequent sales to stabilize prices and to approach the average price during the marketing period.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

6. Forward contracting: use of contractual agreements with a local elevator product handler or input supplier which specify price, quantity, time and perhaps other stipulations of commodity and/or input delivery.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

7. Use of futures markets: hedging on futures markets of stabilize commodity prices.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

8. Market information: obtaining outlook information and reports on market conditions that contribute to knowledge of expected prices.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

9. Government commodity programs: maintaining eligibility for government loan, price support and income programs.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

10. Hail insurance: purchasing hail insurance as a safeguard against hail damage.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

11. All-risk crop insurance: purchasing all-risk crop insurance as a safeguard against loss due to low yields.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

12. Maintaining financial reserves: holding bank accounts, mutual funds, stocks, bonds and other financial assets as a reserve for bad times.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

13. Holding investory reserves: maintaining inventories of grain or other commodities as a reserve for bad times.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

14. Holding credit reserve: limiting borrowing to have a reserve of unloaned funds to draw upon in response to unexpected events.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

15. Debt management: working with primary lenders to carry over loans, defer payments, refinance or otherwise restructure indebtedness for orderly payoff under adversity.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

16. Utilizing government credit programs: become eligible for and using government (FmHA) emergency credit programs.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

________________________________________

________________________________________

________________________________________

17. Maintaining flexibility in farm organization: ability to change enterprises, marketing policies, production systems and investment plans with changes in operating environment.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

________________________________________

________________________________________

________________________________________

18. Idling production capacity: ability to idle acreage, livestock production or other productive capacity with changes in operating capacity.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

19. Pacing of investments and expansion: plan capital expenditures (machinery, facilities, breeding livestock and land) to avoid becoming overextended).

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

______________________________________________

______________________________________________

______________________________________________

20. Off-farm activities by farm operator: complement farm activities and income with part- or full-time off-farm work. May be farm related like seed or fertilizer sales, grain hauling, custom work, etc.

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

21. Off-farm activities by other family members: family members complement farm activities and income with off-farm employment..

a. How important is this method to you? (Please circle appropriate response.)

| Very Important | Moderately Important | | Slightly Important | Not Important | Does Not Apply |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 0 |

b. Do you use this method? No ______ Yes ______

If you use this method, please provide a brief description of how you use it.

22. Do you practice other responses to variability that are not mentioned above? If yes, please indicate what they are.

## IV. Information Needs for Dealing with Risk/Variability

1. What are the key farm decisions that you must make?

________________________________________________

________________________________________________

________________________________________________

________________________________________________

2. What types of information are most useful in making these decisions?

________________________________________________

________________________________________________

________________________________________________

________________________________________________

3. If you take an action which increases risk/variability in one aspect of your operation, do you try to offset or balance this with other actions in another part of the business?

________________________________________________

________________________________________________

________________________________________________

________________________________________________

4. Have your responses to risk/variability resulted from or been influenced by other people or institutions (e.g., lenders, etc.) with whom you deal? If so, how?

________________________________________________

________________________________________________

________________________________________________

________________________________________________

## V. Socioeconomic Information

The information in this section, like the previous sections, is strictly confidential. It is important because your attitudes and responses may be related to these characteristics.

Please complete or check the appropriate response.

1. Age of primary operator(s) ____________________

2. Education level of the primary operator(s)

| | |
|---|---|
| Some high school | ________ |
| High school graduate | ________ |
| Technical or vocational school | ________ |
| Some college | ________ |
| 2-year graduate | ________ |
| 4-year graduate | ________ |

3. Years of farming experience ____________________

4. Marital status ____________________

5. Number of dependents ____________________

6. Race of primary operator(s) ____________________

7. Approximate firm and family net worth

| | Firm | Family |
|---|---|---|
| Less than $100,000 | ________ | ________ |
| $100,000 to $249,999 | ________ | ________ |
| $250,000 to $499,999 | ________ | ________ |
| $500,000 to $999,999 | ________ | ________ |
| $1,000,000 to $2,499,999 | ________ | ________ |
| $2,500,000 to $5,000,000 | ________ | ________ |
| Over $5,000,000 | ________ | ________ |

8. Days spent in off-farm employment per year by operator ______

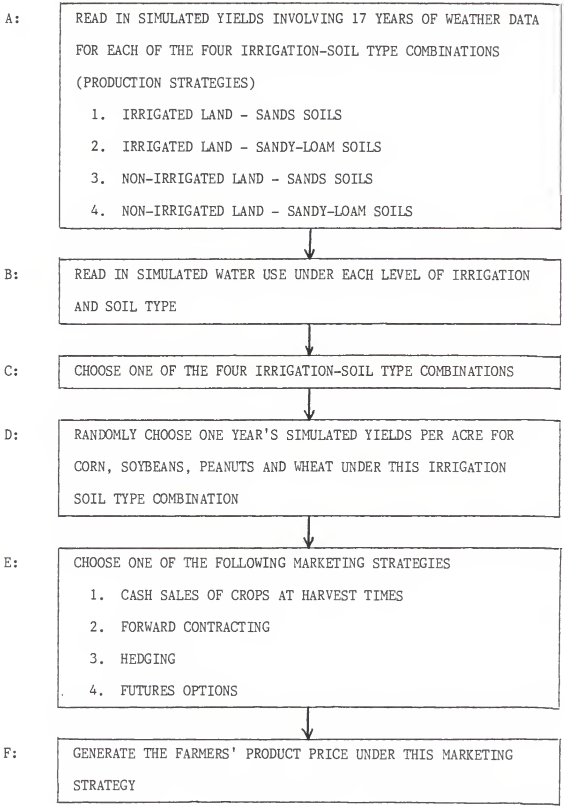
9. Amount of debts currently outstanding. (Please check the correct categories.)

| | Short-term (less than 1 year) | Intermediate and long-term (over 1 year) |
|---|---|---|
| $0 | | |
| $25,000-$49,999 | | |
| $50,000-$74,999 | | |
| $75,000-$99,999 | | |
| $100,000-$149,999 | | |
| $150,000-$199,999 | | |
| $200,000-$249,999 | | |
| $250,000-$499,999 | | |
| $500,000-$999,999 | | |
| $1,000,000-$4,999,999 | | |
| Over $5,000,000 | | |

10. Approximate farm and total family income, 1980-1982. (Please check the correct categories.)

| | Farm | | | Family | | |
|---|---|---|---|---|---|---|
| | 1980 | 1981 | 1982 | 1980 | 1981 | 1982 |
| Negative - loss | | | | | | |
| $0-$4,999 | | | | | | |
| $5,000-$9,999 | | | | | | |
| $10,000-$19,999 | | | | | | |
| $20,000-$29,999 | | | | | | |
| $30,000-$49,999 | | | | | | |
| $50,000-$99,999 | | | | | | |
| Over $100,000 | | | | | | |

# APPENDIX B
# STEPS INVOLVED IN BUILDING THE INCOME SIMULATION MODEL



A: READ IN SIMULATED YIELDS INVOLVING 17 YEARS OF WEATHER DATA FOR EACH OF THE FOUR IRRIGATION-SOIL TYPE COMBINATIONS (PRODUCTION STRATEGIES)

1. IRRIGATED LAND - SANDS SOILS
2. IRRIGATED LAND - SANDY-LOAM SOILS
3. NON-IRRIGATED LAND - SANDS SOILS
4. NON-IRRIGATED LAND - SANDY-LOAM SOILS

B: READ IN SIMULATED WATER USE UNDER EACH LEVEL OF IRRIGATION AND SOIL TYPE

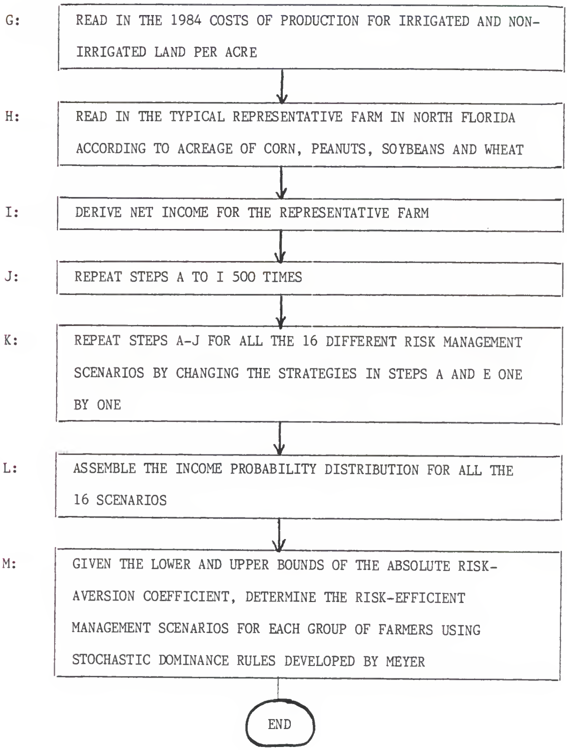
C: CHOOSE ONE OF THE FOUR IRRIGATION-SOIL TYPE COMBINATIONS

D: RANDOMLY CHOOSE ONE YEAR'S SIMULATED YIELDS PER ACRE FOR CORN, SOYBEANS, PEANUTS AND WHEAT UNDER THIS IRRIGATION SOIL TYPE COMBINATION

E: CHOOSE ONE OF THE FOLLOWING MARKETING STRATEGIES

1. CASH SALES OF CROPS AT HARVEST TIMES
2. FORWARD CONTRACTING
3. HEDGING
4. FUTURES OPTIONS

F: GENERATE THE FARMERS' PRODUCT PRICE UNDER THIS MARKETING STRATEGY



G: READ IN THE 1984 COSTS OF PRODUCTION FOR IRRIGATED AND NON-IRRIGATED LAND PER ACRE

H: READ IN THE TYPICAL REPRESENTATIVE FARM IN NORTH FLORIDA ACCORDING TO ACREAGE OF CORN, PEANUTS, SOYBEANS AND WHEAT

I: DERIVE NET INCOME FOR THE REPRESENTATIVE FARM

J: REPEAT STEPS A TO I 500 TIMES

K: REPEAT STEPS A-J FOR ALL THE 16 DIFFERENT RISK MANAGEMENT SCENARIOS BY CHANGING THE STRATEGIES IN STEPS A AND E ONE BY ONE

L: ASSEMBLE THE INCOME PROBABILITY DISTRIBUTION FOR ALL THE 16 SCENARIOS

M: GIVEN THE LOWER AND UPPER BOUNDS OF THE ABSOLUTE RISK-AVERSION COEFFICIENT, DETERMINE THE RISK-EFFICIENT MANAGEMENT SCENARIOS FOR EACH GROUP OF FARMERS USING STOCHASTIC DOMINANCE RULES DEVELOPED BY MEYER

# APPENDIX C

## SIMULATED YIELDS AND IRRIGATION WATER USE FOR CORN, PEANUTS, SOYBEANS AND WINTER WHEAT FOR 17 WEATHER OR "PRODUCTION" YEARS (1955-1971) USED AS DATA IN THE INCOME SIMULATION MODEL

Table C-1. Corn Yields in Bushels per Acre

| Weather Year | Irrigated | | Non-Irrigated | |
|---|---|---|---|---|
| | Sands Soils | Sandy-Loam Soils | Sands Soils | Sandy-Loam Soils |
| 1955 | 118.00 | 118.00 | 37.00 | 49.00 |
| 1956 | 132.00 | 132.00 | 38.00 | 54.00 |
| 1957 | 112.00 | 112.00 | 61.00 | 78.00 |
| 1958 | 140.00 | 141.00 | 79.00 | 89.00 |
| 1959 | 115.00 | 116.00 | 70.00 | 87.00 |
| 1960 | 154.00 | 157.00 | 50.00 | 87.00 |
| 1961 | 131.00 | 138.00 | 63.00 | 90.00 |
| 1962 | 134.00 | 132.00 | 37.00 | 57.00 |
| 1963 | 126.00 | 133.00 | 97.00 | 94.00 |
| 1964 | 140.00 | 148.00 | 17.00 | 43.00 |
| 1965 | 122.00 | 121.00 | 6.00 | 26.00 |
| 1966 | 125.00 | 127.00 | 35.00 | 31.00 |
| 1967 | 149.00 | 149.00 | 52.00 | 57.00 |
| 1968 | 123.00 | 127.00 | 79.00 | 91.00 |
| 1969 | 129.00 | 128.00 | 25.00 | 47.00 |
| 1970 | 111.00 | 111.00 | 17.00 | 35.00 |
| 1971 | 115.00 | 125.00 | 57.00 | 63.00 |
| Average | (128.00) | (130.00) | (48.00) | (63.00) |
| Standard Deviation | (12.35) | (12.67) | (24.34) | (22.63) |

Table C-2. Peanuts Yields in Pounds per Acre

| Weather Year | Irrigated | | Non-Irrigated | |
|---|---|---|---|---|
| | Sands Soils | Sandy-Loam Soils | Sands Soils | Sandy-Loam Soils |
| 1955 | 4041.00 | 4080.00 | 3154.00 | 3764.00 |
| 1956 | 4230.00 | 4111.00 | 3541.00 | 3837.00 |
| 1957 | 3109.00 | 3060.00 | 2605.00 | 2711.00 |
| 1958 | 4309.00 | 4042.00 | 2402.00 | 2856.00 |
| 1959 | 4197.00 | 4413.00 | 2294.00 | 3167.00 |
| 1960 | 4246.00 | 3995.00 | 2724.00 | 3626.00 |
| 1961 | 3851.00 | 4160.00 | 3198.00 | 3582.00 |
| 1962 | 3900.00 | 4183.00 | 2488.00 | 2565.00 |
| 1963 | 4104.00 | 4160.00 | 3198.00 | 3582.00 |
| 1964 | 3747.00 | 4101.00 | 3415.00 | 4078.00 |
| 1965 | 3965.00 | 3923.00 | 2508.00 | 3494.00 |
| 1966 | 3961.00 | 3818.00 | 2693.00 | 3342.00 |
| 1967 | 4005.00 | 3702.00 | 2740.00 | 3067.00 |
| 1968 | 3840.00 | 3734.00 | 2390.00 | 3006.00 |
| 1969 | 3894.00 | 3824.00 | 3730.00 | 3665.00 |
| 1970 | 3976.00 | 3965.00 | 2188.00 | 3185.00 |
| 1971 | 3650.00 | 3316.00 | 2899.00 | 3280.00 |
| Average | (3943.00) | (3917.00) | (2781.00) | (3346.00) |
| Standard Deviation | (272.00) | (321.00) | (466.00) | (407.00) |

Table C-3. Soybeans Yields in Bushels per Acre

| Weather Year | Irrigated |  | Non-Irrigated |  |
|---|---|---|---|---|
|  | Sands Soils | Sandy-Loam Soils | Sands Soils | Sandy-Loam Soils |
| 1955 | 54.00 | 55.00 | 35.00 | 43.00 |
| 1956 | 53.00 | 54.00 | 17.00 | 19.00 |
| 1957 | 53.00 | 54.00 | 28.00 | 33.00 |
| 1958 | 55.00 | 56.00 | 16.00 | 22.00 |
| 1959 | 54.00 | 55.00 | 32.00 | 43.00 |
| 1960 | 55.00 | 55.00 | 44.00 | 47.00 |
| 1961 | 54.00 | 55.00 | 35.00 | 44.00 |
| 1962 | 57.00 | 57.00 | 19.00 | 28.00 |
| 1963 | 53.00 | 53.00 | 18.00 | 26.00 |
| 1964 | 52.00 | 53.00 | 34.00 | 44.00 |
| 1965 | 54.00 | 55.00 | 28.00 | 36.00 |
| 1966 | 54.00 | 55.00 | 19.00 | 26.00 |
| 1967 | 53.00 | 53.00 | 27.00 | 36.00 |
| 1968 | 56.00 | 57.00 | 28.00 | 38.00 |
| 1969 | 54.00 | 56.00 | 44.00 | 52.00 |
| 1970 | 56.00 | 56.00 | 16.00 | 26.00 |
| 1971 | 54.00 | 55.00 | 43.00 | 52.00 |
| Average | (54.00) | (55.00) | (28.00) | (36.00) |
| Standard Deviation | (1.28) | (1.21) | (9.57) | (10.00) |

Table C-4. Winter Wheat Yields in Bushels per Acre

| Weather Year | Non-Irrigated | |
|---|---|---|
| | Sands Soils | Sandy-Loam Soils |
| 1955 | 32.72 | 48.83 |
| 1956 | 44.84 | 50.00 |
| 1957 | 42.66 | 49.85 |
| 1958 | 45.00 | 50.00 |
| 1959 | 45.00 | 50.00 |
| 1960 | 45.00 | 50.00 |
| 1961 | 45.00 | 50.00 |
| 1962 | 45.00 | 50.00 |
| 1963 | 45.00 | 50.00 |
| 1964 | 45.00 | 50.00 |
| 1965 | 44.99 | 50.00 |
| 1966 | 43.95 | 50.00 |
| 1967 | 44.67 | 50.00 |
| 1968 | 43.94 | 49.99 |
| 1969 | 44.99 | 50.00 |
| 1970 | 45.00 | 50.00 |
| 1971 | 45.00 | 50.00 |
| Average | 43.98 | 49.92 |

Table C-5. Corn Irrigation Water Use in Acre-Inches

| Weather Year | Sands Soils | Sandy-Loam Soils |
|---|---|---|
| 1955 | 15.00 | 13.33 |
| 1956 | 16.00 | 13.33 |
| 1957 | 10.00 | 9.33 |
| 1958 | 14.00 | 12.00 |
| 1959 | 9.00 | 9.33 |
| 1960 | 16.00 | 13.33 |
| 1961 | 15.00 | 13.33 |
| 1962 | 15.00 | 12.00 |
| 1963 | 13.00 | 12.00 |
| 1964 | 16.00 | 13.33 |
| 1965 | 12.00 | 12.00 |
| 1966 | 15.00 | 14.67 |
| 1967 | 17.00 | 16.00 |
| 1968 | 14.00 | 12.00 |
| 1969 | 14.00 | 12.00 |
| 1970 | 12.00 | 10.67 |
| 1971 | 14.00 | 12.00 |
| Average | (14.00) | (12.39) |
| Standard Deviation | (2.10) | (1.63) |

Table C-6. Peanuts Irrigation Water Use in Acre-Inches

| Weather Year | Sands Soils | Sandy-Loam Soils |
|---|---|---|
| 1955 | 13.00 | 5.33 |
| 1956 | 12.00 | 5.33 |
| 1957 | 8.00 | 5.33 |
| 1958 | 17.00 | 12.00 |
| 1959 | 16.00 | 8.00 |
| 1960 | 13.00 | 6.67 |
| 1961 | 12.00 | 6.67 |
| 1962 | 17.00 | 9.33 |
| 1963 | 12.00 | 8.00 |
| 1964 | 11.00 | 4.00 |
| 1965 | 12.00 | 6.67 |
| 1966 | 15.00 | 10.67 |
| 1967 | 14.00 | 9.33 |
| 1968 | 14.00 | 6.67 |
| 1969 | 9.00 | 4.00 |
| 1970 | 17.00 | 10.67 |
| 1971 | 7.00 | 2.67 |
| Average | (12.88) | (7.14) |
| Standard Deviation | (3.28) | (2.54) |

Table C-7. Soybeans Irrigation Water Use in Acre-Inches

| Weather Year | Sands Soils | Sandy-Loam Soils |
|---|---|---|
| 1955 | 12.20 | 9.00 |
| 1956 | 12.60 | 9.40 |
| 1957 | 11.00 | 7.90 |
| 1958 | 13.00 | 10.60 |
| 1959 | 9.00 | 6.70 |
| 1960 | 8.70 | 5.50 |
| 1961 | 10.20 | 8.70 |
| 1962 | 9.80 | 7.90 |
| 1963 | 11.80 | 9.40 |
| 1964 | 8.30 | 6.70 |
| 1965 | 10.20 | 7.90 |
| 1966 | 9.80 | 7.90 |
| 1967 | 13.00 | 9.80 |
| 1968 | 10.60 | 7.90 |
| 1969 | 5.50 | 2.40 |
| 1970 | 12.20 | 9.00 |
| 1971 | 9.40 | 5.90 |
| Average | (10.50) | (7.80) |
| Standard Deviation | (1.90) | (1.80) |

# APPENDIX D
# CASH PRICES FOR CORN, PEANUTS, SOYBEANS AND WINTER WHEAT FROM 1970 TO 1984 USED AS DATA IN THE INCOME SIMULATION MODEL

Table D-1. Cash Prices for Corn per Bushel in Dollars

| Year | (1) Average Harvest Time Price Aug. 1-15 | (2) Average Planting Time Price Mar. 8-22 | (3) Change in Cash Prices (CICP) (1) - (2) |
|---|---|---|---|
| 1984[a] | 3.0237 | 3.7454 | -0.7217 |
| 1983 | 3.5718 | 3.1305 | +0.4413 |
| 1982 | 2.3880 | 2.6391 | -0.2511 |
| 1981 | 2.7695 | 3.3910 | -0.6215 |
| 1980 | 3.2000 | 2.7540 | +0.4460 |
| 1979 | 2.6336 | 2.4973 | +0.1363 |
| 1978[b] | 2.20 | 2.30 | -0.1000 |
| 1977 | 1.72 | 2.60 | -0.8800 |
| 1976 | 2.57 | 2.69 | -0.1200 |
| 1975 | 2.94 | 2.88 | +0.0600 |
| 1974 | 3.45 | 3.00 | +0.4500 |
| 1973 | 2.90 | 1.76 | +1.1400 |
| 1972 | 1.30 | 1.30 | 0.0000 |
| 1971 | 1.50 | 1.65 | -0.1500 |
| 1970 | 1.49 | 1.43 | +0.0600 |
| Average | 2.5104 | 2.5178 | -0.0074 |
| Standard Deviation | 0.7040 | 0.6972 | 0.4975 |
| Coefficient of Variation | 0.2804 | 0.2743 | -67.2289 |

[a] For 1979-1984, the average two-week prices were obtained from Goldkist district office in Campbellton and the University of Florida Agricultural Research Center in Marianna.

[b] For 1970-1978, the average monthly prices were obtained from the Georgia Crop Reporting Service with the harvest time in August and the planting time in March.

## Peanuts Price per Pound - 1984

The government set price is $0.2775 at planting time according to Mr. Tim Hewitt of Marianna Agricultural Research Center.

Peanuts is a restricted crop and hence the change in cash price from planting time to harvest time is 0.00 for all the 15 years modeled in the income simulation model.

Table D-2. Cash Prices for Soybeans per Bushel in Dollars

| Year | (1) Average Harvest Time Price Nov. 1-15 | (2) Average Planting Time Price May 22-June 5 | (3) Change in Cash Prices (CICP) (1) - (2) |
|---|---|---|---|
| 1984[a] | 6.1086 | 8.5867 | -2.4781 |
| 1983 | 8.3000 | 5.9294 | +2.3706 |
| 1982 | 5.3356 | 6.1282 | -0.7926 |
| 1981 | 6.0235 | 7.1490 | -1.1255 |
| 1980 | 8.5643 | 5.8320 | +2.7323 |
| 1979 | 6.0289 | 7.2270 | -1.1981 |
| 1978[b] | 6.23 | 7.11 | -0.8800 |
| 1977 | 5.71 | 8.93 | -3.2200 |
| 1976 | 6.15 | 4.90 | +1.2500 |
| 1975 | 4.40 | 5.10 | -0.7000 |
| 1974 | 7.41 | 5.20 | +2.2100 |
| 1973 | 5.14 | 7.65 | -2.5100 |
| 1972 | 3.36 | 3.30 | +0.06 |
| 1971 | 2.80 | 3.00 | -0.20 |
| 1970 | 2.90 | 2.55 | +0.35 |
| Average | 5.6303 | 5.9061 | -0.2494 |
| Standard Deviation | 2.3728 | 3.5217 | 3.07786 |
| Coefficient of Variation | 0.4214 | 0.3177 | -7.0344 |

---

[a] For 1979-1984, the average two-week prices were obtained from Goldkist district office in Campbellton and the University of Florida Agricultural Research Center in Marianna.

[b] For 1970-1978, the average monthly prices were obtained from the Georgia Crop Reporting Service with the harvest time in November and the planting time in May.

Table D-3. Cash Prices for Winter Wheat per Bushel in Dollars

| Year | (1) Harvest Time Price May 16-31 | (2) Planting Time Price Nov. 15-30 | (3) Change in Cash Price (CICP) (3) = (1) - (2) | Source of Data |
|---|---|---|---|---|
| 1983-84 | 3.3645 | 3.1436 | +0.2209 | North Florida[a] |
| 1982-83 | 3.63 | 3.48 | +0.15 | U.S.[b] |
| 1981-82 | 3.01 | 3.22 | -0.21 | Georgia[c] |
| 1980-81 | 3.80 | 4.22 | -0.42 | U.S. |
| 1979-80 | 3.54 | 3.94 | -0.40 | U.S. |
| 1978-79 | 3.25 | 3.10 | +0.15 | U.S. |
| 1977-78 | 2.80 | 2.42 | +0.38 | U.S. |
| 1976-77 | 2.19 | 2.39 | -0.20 | U.S. |
| 1975-76 | 3.12 | 3.17 | -0.05 | U.S. |
| 1974-75 | 2.99 | 3.76 | -0.77 | Georgia |
| 1973-74 | 3.60 | 3.80 | -0.20 | Georgia |
| 1972-73 | 2.22 | 1.77 | +0.45 | Georgia |
| 1971-72 | 1.38 | 1.39 | -0.01 | Georgia |
| 1970-71 | 1.66 | 1.55 | +0.11 | Georgia |
| 1969-70 | 1.35 | 1.35 | 0.00 | Georgia |
| Mean | 2.7936 | 2.8469 | -0.0533 | |
| Standard Deviation | 0.8044 | 0.9386 | 0.3126 | |
| C.V.[f] | 0.2879 | 0.3297 | -5.8658 | |

[a] The prices from North Florida are obtained from Goldkist district office in Campbellton and the University of Florida Agricultural Research Center in Marianna.

[b] The average United States prices are obtained from various issues of Agricultural Prices published by the Department of Agriculture.

[c] The prices from Georgia are obtained from the Georgia Crop Reporting Service.

[d] The 1983-84 prices were two-week average; 1975-76 to 1980-81 and 1982-83 were monthly prices; and 1969-70 to 1974-75 and 1981-82 were mid-month prices.

[e] The 1984-85 North Florida planting time price is $3.0900.

[f] C.V. equals Coefficient of Variation.

# APPENDIX E

## FUTURES PRICES FROM 1970 TO 1984 FOR CORN AND SOYBEANS USED AS DATA FOR THE HEDGING AND FUTURES OPTIONS MARKETING STRATEGIES IN THE INCOME SIMULATION MODEL

Table E-1. Basis[a] Data for August Corn and November Soybeans in Dollars per Bushel for North Florida

| Year | Corn | Soybeans |
|---|---|---|
| 1984 | -0.0550 | 0.5520 |
| 1983 | -0.0768 | 0.2275 |
| 1982 | -0.0293 | 0.2731 |
| 1981 | +0.4255 | 0.4565 |
| 1980 | +0.2025 | 0.3569 |
| 1979 | +0.1651 | 0.4036 |
| 1978 | -0.0004 | 0.4458 |
| 1977 | +0.2444 | 0.0650 |
| 1976 | +0.1925 | 0.4075 |
| 1975 | +0.2162 | 0.4600 |
| 1974 | +0.1867 | 0.7550 |
| 1973 | +0.0450 | 0.3750 |
| 1972 | -0.0263 | 0.2406 |
| 1971 | -0.2600 | 0.3325 |
| 1970 | -0.1257 | 0.1350 |
| Average | 0.0736 | 0.3657 |
| C.V.[b] | 2.4141 | 0.4629 |

[a] Basis is defined as the futures prices minus local cash price at the harvest time.

[b] C.V. stands for the coefficient of variation.

Table E-2. Corn Futures Prices in Dollars per Bushel

| Year | (1) Average Planting Time Price March 8-22 | (2) Average Futures Options Month Delivery Price[a] Aug. 1-15 | (3) Average Harvest Time Price Aug. 1-15 | (4) Change in Futures Price (CIFP) (2) - (1) |
|---|---|---|---|---|
| 1984 | 3.1508 | 2.9687 | 2.9867 | -0.1821 |
| 1983 | 2.9337 | 3.4950 | 3.4950 | +0.5613 |
| 1982 | 2.8262 | 2.3587 | 2.3587 | -0.4675 |
| 1981 | 3.7000 | 3.1950 | 3.1950 | -0.5050 |
| 1980 | 2.9212 | 3.4025 | 3.4025 | -0.4813 |
| 1979 | 2.5258 | 2.7987 | 2.7987 | 0.2729 |
| 1978 | 2.4387 | 2.1962 | 2.1962 | +0.2425 |
| 1977 | 2.6750 | 1.9644 | 1.9644 | -0.7105 |
| 1976 | 2.7312 | 2.7625 | 2.7625 | -0.0313 |
| 1975 | 2.7312 | 3.1562 | 3.1562 | +0.4250 |
| 1974 | 2.9637 | 3.6367 | 3.6367 | +0.6790 |
| 1973 | 1.5317 | 2.9450 | 2.9450 | +0.4133 |
| 1972 | 1.2925 | 1.2737 | 1.2737 | -0.0187 |
| 1971 | 1.5269 | 1.2400 | 1.2400 | -0.2869 |
| 1970 | 1.2094 | 1.3643 | 1.3643 | +0.1549 |
| Average | 2.4772 | 2.5850 | 2.5850 | 0.1071 |
| Standard Deviation | 0.7161 | 0.7863 | 0.7863 | 0.5521 |
| C.V.[b] | 0.2891 | 0.3042 | 0.3042 | 5.1543 |

[a] The futures option has to be exercised one month before the month of the futures. In this study, it is one month before the harvest date since the farmer is assumed to contract for delivery of the futures at harvest time. The month of the futures for corn is September.

[b] C.V. stands for the coefficient of variation.

SOURCE: Chicago Board of Trade.

Table E-3. Soybeans Futures Prices in Dollars per Bushel

| Year | (1) Average Planting Time Price May 22–June 5 | (2) Average Futures Options Month Delivery Price[a] Oct. 1-15 | (3) Average Harvest Time Price Nov. 1-15 | (4) Change in Futures Price (CIFP) (2) - (1) |
|---|---|---|---|---|
| 1984 | 7.4488 | 6.0288 | 6.1638 | -1.4200 |
| 1983 | 6.3388 | 8.6275 | 8.5275 | +2.2887 |
| 1982 | 6.4412 | 5.3987 | 5.6087 | -1.0425 |
| 1981 | 7.6050 | 6.5708 | 6.4800 | -1.0342 |
| 1980 | 6.5342 | 8.0600 | 8.9212 | +1.5258 |
| 1979 | 7.2312 | 6.9800 | 6.4325 | -0.2512 |
| 1978 | 6.6375 | 6.7950 | 6.6758 | +0.1575 |
| 1977 | 7.5838 | 5.3575 | 5.7750 | -2.2263 |
| 1976 | 5.7775 | 6.4375 | 6.5575 | +0.6600 |
| 1975 | 4.9625 | 5.5475 | 4.8600 | +0.5850 |
| 1974 | 5.4087 | 9.2000 | 8.1650 | +3.7913 |
| 1973 | 5.9275 | 6.2700 | 5.5150 | +0.3425 |
| 1972 | 3.2300 | 3.4019 | 3.5906 | +0.1719 |
| 1971 | 3.0368 | 3.1850 | 3.1325 | +0.1428 |
| 1970 | 2.5900 | 2.9096 | 3.0350 | +0.3196 |
| Average | 5.7836 | 6.0513 | 5.9627 | 0.2674 |
| Standard Deviation | 1.6033 | 1.8035 | 1.7389 | 1.4912 |
| C.V.[b] | 0.2772 | 0.2980 | 0.2916 | 5.5768 |

[a] The futures option has to be exercised one month before the month of the futures. In this study, it is one month before the harvest date since the farmer is assumed to contract for delivery of the futures at harvest time. The month of soybeans futures is November.

[b] C.V. stands for the coefficient of variation.

SOURCE: Chicago Board of Trade.

# APPENDIX F

## ESTIMATED 1984 COSTS OF PRODUCTION OF CORN, PEANUTS, SOYBEANS AND WINTER WHEAT (EXCLUDING COSTS OF IRRIGATION) FOR NORTH FLORIDA USED FOR THE INCOME SIMULATION MODEL

Table F-1. Estimated Costs of Producing One Acre of Dryland Corn, North Florida, 1984

| Item | Unit | Quantity | Price | Value |
|---|---|---|---|---|
| Cash Expenses: | | | | |
| Seed | lb | 12.0 | 1.10 | 13.20 |
| Fertilizer (5-10-15 or equivalent) | cwt | 5.0 | 6.50 | 32.50 |
| Ammonium nitrate | cwt | 4.0 | 8.50 | 34.00 |
| Lime spread | ton | .33 | 18.00 | 6.00 |
| Insecticide | lb | 15.0 | .86 | 12.90 |
| Herbicide | acre | 1.0 | 18.50 | 18.50 |
| Tractor (135 hp) | hr | 1.35 | 8.95 | 12.08 |
| Truck, pickup | mi | 20.0 | .12 | 2.40 |
| Truck, 2-ton | mi | 20.0 | .18 | 3.60 |
| Other machinery | hr | 1.35 | 1.90 | 2.57 |
| Labor | hr | 3.0 | 4.00 | 12.00 |
| Combine | hr | .33 | 17.96 | 5.93 |
| Land rent | acre | 1.0 | 20.00 | 20.00 |
| Interest on cash expense[a] | $ | 175.68 | .055 | 9.66 |
| Total Cash Expenses | | | | 185.34 |
| Fixed Costs: | | | | |
| Tractor (135 hp) | hr | 1.35 | 11.02 | 14.88 |
| Truck, pickup | mi | 20.0 | .15 | 3.00 |
| Truck, 2-ton | mi | 20.0 | .21 | 4.20 |
| Combine | hr | .33 | 39.08 | 12.90 |
| Other machinery | hr | 1.35 | 3.58 | 4.83 |
| Total Fixed Costs | | | | 39.81 |
| TOTAL COSTS | | | | 225.15 |

[a] Eleven percent for 6 months.

Prepared by Timothy D. Hewitt, Area Economist, Food and Resource Economics Department, University of Florida, ARC, Marianna.

Table F-2. Estimated Costs of Producing One Acre of Peanuts, North Florida, 1984

| Item | Unit | Quantity | Price | Value |
|---|---|---|---|---|
| Cash Expenses: | | | | |
| Seed | lb | 90.00 | .65 | 58.50 |
| Fertilizer (5-10-15 or equivalent) | cwt | 5.0 | 7.35 | 36.75 |
| Lime | ton | .5 | 18.00 | 9.00 |
| Gypsum (dry) | cwt | 6.0 | 2.00 | 12.00 |
| Herbicide | acre | 1.0 | 45.00 | 45.00 |
| Insecticide | acre | 1.0 | 33.00 | 33.00 |
| Fungicide | acre | 1.0 | 40.00 | 40.00 |
| Nematicide | acre | 1.0 | 80.00 | 80.00 |
| Spraying (air) | appl | 4.0 | 3.50 | 14.00 |
| Scouting fee | acre | 1.0 | 3.00 | 3.00 |
| Tractor (135 hp) | hr | 3.0 | 8.95 | 26.85 |
| Tractor (50 hp) | hr | 2.25 | 3.29 | 7.40 |
| Equipment | hr | 5.25 | 3.04 | 15.96 |
| Truck, pickup | mi | 40.0 | .12 | 4.80 |
| Truck, 2-ton | mi | 20.0 | .18 | 3.60 |
| Drying & cleaning | ton | 1.75 | 27.00 | 47.25 |
| Peanut Commission | ton | 1.75 | 2.00 | 3.50 |
| Labor | hr | 8.0 | 4.00 | 32.00 |
| Interest on cash expense[a] | $ | 472.61 | .055 | 25.99 |
| Total Cash Expenses | | | | 498.60 |
| Fixed Costs: | | | | |
| Tractor (135 hp) | hr | 3.0 | 11.02 | 33.06 |
| Tractor (50 hp) | hr | 2.25 | 3.75 | 8.44 |
| Truck, pickup | mi | 40.0 | .15 | 6.00 |
| Truck, 2-ton | mi | 20.0 | .21 | 4.20 |
| Equipment | hr | 5.25 | 8.92 | 46.83 |
| Total Fixed Costs | | | | 98.53 |
| TOTAL COSTS | | | | 597.13 |

[a] Eleven percent for 6 months.

Prepared by Timothy D. Hewitt, Area Economist, Food and Resource Economics Department, University of Florida, ARC, Marianna.

Table F-3. Estimated Costs of Producing One Acre of Soybeans, North Florida, 1984

| Item | Unit | Quantity | Price | Value |
|---|---|---|---|---|
| Cash Expenses: | | | | |
| Seed | bu | .80 | 15.00 | 12.00 |
| Inoculant | pkg | 1.00 | 1.00 | 1.00 |
| Fertilizer (5-10-15 or equivalent) | cwt | 5.00 | 7.50 | 37.50 |
| Lime | ton | .33 | 18.00 | 6.00 |
| Herbicide | acre | 1.00 | 20.50 | 20.50 |
| Insecticide | acre | 1.00 | 17.00 | 17.00 |
| Spraying (air) | appl | 3.00 | 3.50 | 10.50 |
| Scouting fee | acre | 1.00 | 3.00 | 3.00 |
| Tractor (135 hp) | hr | 1.30 | 8.95 | 11.00 |
| Truck, pickup | mi | 20.00 | .12 | 2.40 |
| Truck, 2-ton | mi | 20.00 | .18 | 3.60 |
| Combine | hr | .33 | 17.96 | 5.93 |
| Other machinery | hr | 1.30 | 1.87 | 2.43 |
| Labor | hr | 3.00 | 4.00 | 12.00 |
| Land rent | acre | 1.00 | 30.00 | 30.00 |
| Interest on cash expense[a] | $ | 175.50 | .055 | 9.65 |
| Total Cash Expenses | | | | 185.15 |
| Fixed Costs: | | | | |
| Tractor (135 hp) | hr | 1.30 | 11.02 | 14.33 |
| Truck, pickup | mi | 20.00 | .15 | 3.00 |
| Truck, 2-ton | mi | 20.00 | .21 | 4.20 |
| Combine | hr | .33 | 39.08 | 12.90 |
| Other machinery | hr | 1.30 | 3.38 | 4.39 |
| Total Fixed Costs | | | | 38.82 |
| TOTAL COSTS | | | | 223.97 |

[a] Eleven percent for 6 months.

Prepared by Timothy D. Hewitt, Area Economist, Food and Resource Economics Department, University of Florida, ARC, Marianna.

Table F-4. Estimated Costs of Producing One Acre of Winter Wheat, North Florida, 1984

| Item | Unit | Quantity | Price | Value |
|---|---|---|---|---|
| Cash Expenses: | | | | |
| Seed | bu | 1.50 | 7.25 | 10.88 |
| Fertilizer (5-10-15 or equivalent) | cwt | 6.00 | 6.50 | 39.00 |
| Nitrogen | lb | 60.00 | .29 | 17.40 |
| Lime | ton | .33 | 18.00 | 6.00 |
| Fungicide | lb | 6.00 | 1.75 | 10.50 |
| Tractor (135 hp) | hr | .75 | 8.95 | 6.71 |
| Tractor (50 hp) | hr | .50 | 3.29 | 1.65 |
| Truck, pickup | mi | 10.00 | .12 | 1.20 |
| Truck, 2-ton | mi | 10.00 | .18 | 1.80 |
| Machinery | hr | 1.15 | 1.70 | 1.96 |
| Combine | hr | .33 | 17.96 | 5.93 |
| Labor | hr | 2.00 | 4.00 | 8.00 |
| Land rent | acre | 1.00 | 15.00 | 15.00 |
| Interest on cash expense[a] | $ | 126.03 | .055 | 6.93 |
| Total Cash Expenses | | | | 132.96 |
| Fixed Costs: | | | | |
| Tractor (135 hp) | hr | .75 | 11.02 | 8.27 |
| Tractor (50 hp) | hr | .50 | 3.75 | 1.88 |
| Combine | hr | .33 | 39.08 | 12.90 |
| Truck, pickup | mi | 10.00 | .15 | 1.50 |
| Truck, 2-ton | mi | 10.00 | .21 | 2.10 |
| Other machinery | hr | 1.15 | 3.42 | 3.93 |
| Total Fixed Costs | | | | 30.58 |
| TOTAL COSTS | | | | 163.54 |

[a] Eleven percent for 6 months.

Prepared by Timothy D. Hewitt, Area Economist, Food and Resource Economics Department, University of Florida, ARC, Marianna.

# APPENDIX G
# ITEMS USED TO ESTIMATE THE COSTS OF IRRIGATION FOR THE TYPICAL FARM IN NORTH FLORIDA FOR 1984

## Center Pivot System (Medium Pressure)
160 Acres System (138 Acres),
One Pivot, Six Applications per Year (1" Each)

| | Amount in Dollars |
|---|---|
| Investment costs | |
| Well--12"; 300' (20 years, S. L. depreciation) | $ 8,800.00 |
| Pump--includes gearhead (800 gpm, 160 ft TDH) (15 years, S. L. depreciation) | 10,000.00 |
| Power unit--65 hp (12 years, S. L. depreciation) | 11,500.00 |
| Center pivot system (medium pressure); ind. freight and installation (15 years, S. L. depreciation) | 42,000.00 |
| Total Investment Costs | $72,300.00 |
| Interest on Investment | |
| Well, pump, power unit and system @ 12% | 4,338.00 |
| Taxes and insurance charge @ 1% of investment | 673.00 |

### Operating Costs

Diesel fuel--4.0 gal/hr, 420 hrs. pumping time, fuel @ 1.05/gal.

Oil--72 gal @ $15/hr.
Repairs--4.5 hrs @ $15/hr.
Labor--33 hrs @ $4.50/hr.

# APPENDIX H
# THE INCOME SIMULATION MODEL COMPUTER PROGRAM IN FORTRAN

```
$JOB
C      INCOME IS A SIMULATION MODEL PROGRAM FOR A REPRESENTATIVE FARM
C      IN NORTH FLORIDA DEVELOPED BY KWABENA ANAMAN OF THE DEPARTMENT
C      OF FOOD AND RESOURCE ECONOMICS,UNIVERSITY OF FLORIDA,GAINESVILLE
C      FLORIDA. THE PROGRAM IS PART OF THE DOCTORAL DISSERTATION RESEARCH
C      ON THE ECONOMIC ANALYSIS OF FARM-FIRM MANAGEMENT RISK.
C      THIS PROGRAM DERIVES INCOME DISTRIBUTIONS FOR RISK MANAGEMENT
C      SCENARIOS INVOLVING 4 PRODUCTION ALTERNATIVES AND 4 MARKETING
C      ALTERNATIVES(16 RISK MANAGEMENT SCENARIOS OVERALL). IT CAN BE
C      ADAPTED FOR USE BY ANY USER BY SPECIFYING THE REFERENCE YEAR
C      IN THIS STUDY THE REFERENCE YEAR IS 1984. 500 REPLICATIONS ARE USED
C      GENERATE THE INCOME DISTRIBUTION FOR EACH OF THE 16 RISK MANAGEMENT
C      SCENARIOS. THE INCOME DISTRIBUTIONS ARE EVALUATED TO DETERMINE THE
C      RISK-EFFICIENT SCENARIOS FOR DIFFERENT GROUPS OF FARMERS.  THE
C      GROUPS OF FARMERS ARE DEFINED BASED ON THEIR RISK AVERSION
C      COEFFICIENTS. THE STOCHASTIC DOMINANCE TECHNIQUE USED IS BASED ON
C      PROCEDURES DEVELOPED BY DR. JACK MEYER IN 1977. THE TECHNIQUE IS
C      CALLED THE STOCHASTIC DOMINANCE WITH RESPECT TO A FUNCTION. A
C      COMPUTER PROGRAM IS AVAILABLE IN THE DEPARTMENT UNDER THE NAME
C      SDA5 THAT INCORPORATES THE MATHEMATICAL FORMULAE AND METHODS
C      OF THE TECHNIQUE.
C      Y(I,J,L) DENOTES SIMULATED YIELDS FOR 17 YEARS GIVEN 4
C      PRODUCTION ALTERNATIVES FOR CORN,PEANUTS,SOYBEANS AND WHEAT
C      AS BUSHELS PER ACRE. THE FOUR PRODUCTION ALTERNATIVES ARE:
C      (A) PRODUCTION OF THE CROPS ON SANDS SOILS WITH IRRIGATION;
C      (B) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITH IRRIGATION,
C      (C) PRODUCTION OF THE CROPS ON SANDS SOILS WITHOUT IRRIGATION;
C      (D) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITHOUT IRRIGATION;
C      ALL OTHER AGRONOMIC AND MANAGEMENT CONDITIONS ARE ASSUMED TO BE
C      NON-CONSTRAINING.
C      IRRG(I,J,L) DENOTES SIMULATED IRRIGATION WATER USE FOR 17
C      YEARS GIVEN 4 PRODUCTION ALTERNATIVES FOR THE FOUR CROPS.
C      EXPRESSED AS ACRE-INCHES.
C      YIELD(J,L) DENOTES RANDOMLY SELECTED YIELD FOR A PARTICULAR YEAR
C      FOR THE 4 PRODUCTION ALTERNATIVES AND FOR THE 4 CROPS
C      IRRIGA(J,L) DENOTES THE RANDOMLY SELECTED IRRIGATION WATER USE FOR
C      A PARTICULAR YEAR FOR THE 4 PRODUCTION ALTERNATIVES AND THE 4 CROPS.
C      PRICE(J,L) DENOTES THE PRICES GENERATED UNDER THE 4 MARKETING
C      ALTERNATIVES FOR THE 4 CROPS. THE MARKETING  ALTERNATIVES ARE :
C      (A) CASH SALES AT HARVEST TIMES FOR ALL THE 4 CROPS PRODUCED;
C      (B) FORWARD CONTRACTING OF HALF OF THE 4 CROPS PRODUCED. THE OTHER
C      HALF IS SOLD BY CASH SALES AT HARVEST TIMES.
C      (C) HEDGING PART OF THE SOYBEANS AND CORN CROPS PRODUCED.
C      THE REST OF THE SOYBEANS AND CORN PRODUCED PLUS THE ENTIRE
C      QUANTITIES OF WHEAT AND PEANUTS ARE SOLD FOR CASH AT HARVEST TIMES.
C      (D) PART OF THE SOYBEANS AND CORN PRODUCED ARE SOLD UNDER THE NEWLY
C      INTRODUCED AGRICULTURAL OPTIONS SCHEME. THE REST OF THE SOYBEANS AND
C      CORN PRODUCED PLUS THE ENTIRE QUANTITIES  OF WHEAT AND PEANUTS ARE
C      SOLD FOR CASH AT HARVEST TIMES.
C      THE 16 RISK MANAGEMENT SCENARIOS ARE DEFINED AS FOLLOWS:
C      (1) PRODUCTION OF THE CROPS ON SANDS SOILS WITH IRRIGATION.
C      THE MARKETING IS CASH SALES AT THE HARVEST TIMES FOR ALL THE 4 CROPS.
C      (2) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITH IRRIGATION
C      THE MARKETING IS CASH SALES AT THE HARVEST TIMES FOR ALL THE 4 CROPS.
```

```
C     (3) PRODUCTION OF THE CROPS ON SANDS SOILS WITHOUT IRRIGATION
C     THE MARKETING IS CASH SALES AT THE HARVEST TIMES FOR ALL THE 4 CROPS.
C     (4) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITHOUT IRRIGATION
C     THE MARKETING IS CASH SALES AT THE HARVEST TIMES FOR ALL THE 4 CROPS.
C     (5) PRODUCTION OF THE CROPS ON SANDS SOILS WITH IRRIGATION.
C     HALF OF EACH CROP PRODUCED IS FORWARD-CONTRACTED.THE OTHER HALF
C     IS SOLD FOR CASH AT THE HARVEST TIMES.
C     (6) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITH IRRIGATION
C     HALF OF EACH CROP PRODUCED IS FORWARD-CONTRACTED. THE OTHER HALF
C     IS SOLD FOR CASH AT THE HARVEST TIMES.
C     (7) PRODUCTION OF THE CROPS ON SANDS SOILS WITHOUT IRRIGATION
C    HALF OF EACH CROP PRODUCED IS FORWARD CONTRACTED. THE OTHER HALF
C     IS SOLD FOR CASH AT THE HARVEST TIMES.
C     (8) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITHOUT IRRIGATION
C     HALF OF EACH CROP PRODUCED IS FORWARD-CONTACTED. THE OTHER HALF
C     IS SOLD FOR CASH AT THE HARVEST TIMES.
C     (9) PRODUCTION OF THE CROPS ON SANDS SOILS WITH IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE HEDGED. THE REST
C     OF THE SOYBEANS AND CORN PLUS THE ENTIRE QUANTITIES OF WHEAT AND
C     PEANUTS PRODUCED ARE SOLD FOR CASH AT HARVEST TIMES.
C     (10) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITH IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE HEDGED. THE REST
C     OF THE SOYBEANS AND CORN PLUS THE ENTIRE QUANTITIES OF WHEAT AND
C     PEANUTS PRODUCED ARE SOLD FOR CASH AT HARVEST TIMES.
C     (11) PRODUCTION OF THE CROPS ON SANDS SOILS WITHOUT IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE HEDGED. THE REST
C     OF THE SOYBEANS AND CORN PLUS THE ENTIRE QUANTITIES OF WHEAT AND
C     PEANUTS PRODUCED ARE SOLD FOR CASH AT HARVEST TIMES.
C     (12) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITHOUT IRRIGATION.
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE HEDGED. THE REST
C     OF THE SOYBEANS AND CORN PLUS THE ENTIRE QUANTITIES OF WHEAT AND
C     PEANUTS PRODUCED ARE SOLD FOR CASH AT HARVEST TIMES.
C     (13) PRODUCTION OF THE CROPS ON SANDS SOILS WITH IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE SOLD UNDER
C     THE FUTURES OPTIONS SCHEME. THE REST OF THE SOYBEANS AND CORN PLUS
C     THE ENTIRE QUANTITIES OF WHEAT AND PEANUTS PRODUCED ARE SOLD FOR
C     CASH AT THE HARVEST TIMES.
C     (14) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITH IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE SOLD UNDER
C     THE FUTURES OPTIONS SCHEME. THE REST OF THE SOYBEANS AND CORN PLUS
C     THE ENTIRE QUANTITIES OF WHEAT AND PEANUTS PRODUCED ARE SOLD FOR
C     CASH AT THE HARVEST TIMES.
C     (15) PRODUCTION OF THE CROPS ON SANDS SOILS WITHOUT IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE SOLD UNDER
C     THE FUTURES OPTIONS SCHEME. THE REST OF THE SOYBEANS AND CORN PLUS
C     THE ENTIRE QUANTITIES OF WHEAT AND PEANUTS PRODUCED ARE SOLD FOR
C     CASH AT THE HARVEST TIMES.
C     (16) PRODUCTION OF THE CROPS ON SANDY-LOAM SOILS WITHOUT IRRIGATION
C     PART OF THE SOYBEANS AND CORN CROPS PRODUCED ARE SOLD UNDER
C     THE FUTURES OPTIONS SCHEME. THE REST OF THE SOYBEANS AND CORN PLUS
C     THE ENTIRE QUANTITIES OF WHEAT AND PEANUTS PRODUCED ARE SOLD FOR
C     CASH AT THE HARVEST TIMES.
C     CPP(L) DENOTES CASH PRICES AT PLANTING TIME FOR THE 4 CROPS FOR
C     THE REFERENCE YEAR WHICH IS ASSUMED IN THIS MODEL TO BE 1984
```

```
C     CICP(I,L) DENOTES CHANGE IN CASH PRICES BETWEEN PLANTING AND
C     HARVEST TIMES ADJUSTED FOR INFLATION FOR THE 4 CROPS AND 15 YEARS.
C     FCP(L) DENOTES FORWARD CONTRACT PRICES AT PLANTING TIME FOR THE 4
C     4 CROPS IN THE REFERENCE YEAR.
C     FUPP(L) DENOTES THE FUTURES PRICES AT PLANTING TIME FOR
C     SOYBEANS AND CORN FOR THE REFERENCE YEAR.
C     BASIS(I,L) DENOTES THE FUTURES PRICES MINUS THE LOCAL CASH PRICES
C     AT A GIVEN POINT IN TIME FOR 15 YEARS AND FOR SOYBEANS.
C     COMM(L) DENOTES COMMISSION AND BROKERAGE FEES PER BUSHEL FOR
C     SOYBEANS AND CORN IN REFERENCE YEAR.
C     CIFP(L) DENOTES THE CHANGE IN FUTURES PRICES BETWEEN PLANTING AND
C     HARVEST TIMES FOR THE SOYBEANS AND CORN FOR 15 YEARS.
C     PREM(L) DENOTES THE PREMIUM CHARGE PER BUSHEL FOR THE
C     4 CROPS UNDER THE OPTIONS MARKETING ALTERNATIVE.
C     COP(J,L) DENOTES THE COSTS OF PRODUCTION FOR THE 4 DIFFERENT
C     PRODUCTION ALTERNATIVES AND FOR THE 4 CROPS IN THE REFERENCE YEAR.
C     THE COSTS OF PRODUCTION ARE FOR DRYLAND,CONVENTIONAL TILLAGE
C     PRODUCTION ON CLASS 1 LAND. THE CLASS 1 LAND IS DEFINED AS LAND
C     WITH 0-2% SLOPE. HENCE THE COSTS OF PRODUCTION FOR THE 4 CROPS
C     MAY VARY ACCORDING TO THE TYPE OF TILLAGE USED AND THE CLASS OF LAND.
C     CIRRG(J,L) DENOTES THE VARIABLE COSTS OF IRRIGATION PER ACRE FOR THE
C     4 PRODUCTION ALTERNATIVES AND THE 4 CROPS.
C     ACREA(L) DENOTES THE ACREAGE OF THE 4 CROPS FOR A TYPICAL MIXED CROP
C     FARM IN NORTH FLORIDA. THE SIZES FOR THE CROPS ARE CORN-55ACRES
C     PEANUTS-30 ACRES SOYBEANS -100 ACRES AND WINTER WHEAT-50 ACRES.
C     ECP(L) DENOTES EXPECTED CASH PRICES AT HARVEST TIME FOR CROP L
C     WHERE L=1 OR 2 OR 3 OR 4. 1 DENOTES CORN 2 FOR PEANUTS 3 FOR
C     SOYBEANS  AND 4 FOR WINTER WHEAT.
C     AHNP(L) DENOTES THE ACTUAL HEDGING NET PRICE FOR CROP L
C     AONP(L) DENOTES ACTUAL OPTIONS NET PRICE FOR CROP L
C     TCP(J,L) DENOTES THE TOTAL COSTS OF PRODUCTION OF THE FARM FOR
C     PRODUCTION ALTERNATIVE J AND CROP L
C     TPROD(J,L) DENOTES THE TOTAL PRODUCTION OF THE FARM FOR THE
C     UNDER PRODUCTION ALTERNATIVE J AND CROP L. THE UNITS ARE BUSHELS
C     FOR CORN,SOYBEANS  AND WHEAT AND POUNDS FOR PEANUTS.
C     GREV(J,L) DENOTES THE GROSS REVENUES IN DOLLARS OF THE FARM UNDER
C     PRODUCTION ALTERNATIVE J AND CROP L
C     CONREV(J,L) STANDS FOR THE REVENUES OBTAINED FROM CONTRACTING
C     THE SPECIFIED AMOUNT OF CROP L
C     CON(J,L) STANDS FOR THE AMOUNT OF CROP L THAT IS FORWARD-CONTRACTED
C     GIVEN THE PRODUCTION ALTERNATIVE J
C     CODIFF(J,L) STANDS FOR THE DIFFERENCE BETWEEN THE TOTAL QUANTITY
C     OF THE CROP L PRODUCED AND THAT WHICH IS FORWARD-CONTRACTED
C     UNDER THE PRODUCTION ALTERNATIVE J
C     ADIFF(J,L) STANDS FOR THE TOTAL REVENUES OBTAINED FROM SELLING
C     IN THE CASH MARKET THE EXCESS AMOUNT OF CROP L THAT IS NOT
C     FORWARD-CONTRACTED UNDER THE PRODUCTION ALTERNATIVE J
C     HED(J,L) STANDS FOR THE AMOUNT OF THE CROP L THAT IS HEDGED
C     GIVEN THE PRODUCTION ALTERNATIVE J
C     HEDREV(J,L) STANDS FOR THE TOTAL REVENUES OBTAINED FROM HEDGING
C     THE SPECIFIED AMOUNT OF CROP L GIVEN THE PRODUCTION ALTERNATIVE J
C     HEDIFF(J,L) STANDS FOR THE DIFFERENCE BETWEEN THE TOTAL
C     AMOUNT OF CROP L PRODUCED AND THE AMOUNT HEDGED UNDER THE PRODUCTION
C     ALTERNATIVE J
```

```
C     BDIFF(J,L) DENOTES THE TOTAL REVENUES OBTAINED FROM SELLING IN THE
C     CASH MARKET THE EXCESS AMOUNT OF CROP L THAT IS NOT HEDGED UNDER
C     THE PRODUCTION ALTERNATIVE J
C     OPDIFF(J,L) DENOTES THE DIFFERENCE BETWEEN THE TOTAL QUANTITY OF
C     CROP L PRODUCED AND THAT WHICH IS SOLD UNDER THE AGRICULTURAL
C     OPTIONS MARKET FOR THE PRODUCTION ALTERNATIVE J
C     OPT(J,L) DENOTES THE AMOUNT OF CROP L SOLD UNDER THE AGRICULTURAL
C     OPTIONS SCHEME UNDER THE PRODUCTION ALTERNATIVE J
C     OPTREV(J,L) DENOTES THE TOTAL REVENUES OBTAINED FROM SELLING
C     THE SPECIFIED AMOUNT OF CROP L IN THE OPTIONS MARKET GIVEN THE
C     PRODUCTION ALTERNATIVE J
C     CDIFF(J,L) DENOTES THE TOTAL AMOUNT OF REVENUES OBTAINED FROM
C     SELLING IN THE CASH MARKET THE EXCESS AMOUNT OF CROP L NOT SOLD
C     IN THE OPTIONS MARKET
C     NREV(J,L) DENOTES THE NET REVENUES OF THE FARM FOR CROP L
C     GIVEN THE PRODUCTION ALTERNATIVE J
C     INCOME(ITEM,INC) DENOTES THE NET INCOME OF THE FARM FOR EACH OF
C     500 REPLICATIONS GIVEN THE 16 RISK-MANAGEMENT SCENAROS. INC IS A
C     COUNTER REPRESENTING THE SCENARIO NUMBER WHILE ITEM DENOTES THE
C     NUMBER OF REPLICATIONS
C     ACREB(L) DENOTES THE SIZES OF LAND DEVOTED TO IRRIGATING CROP L
C     FICIRR(J,L) DENOTES THE TOTAL FIXED COSTS OF IRRIGATING PER ACRE
C     GIVEN THE 4 PRODUCTION ALTERNATIVES AND THE 4 CROPS
C     STRKP(L) DENOTES THE STRIKE PRICES UNDER THE OPTIONS SCHEME
C     FOR THE 4 CROPS
C
C     THE DECISION VARIABLES USED IN THE STUDY ARE ACREA(L),CIRRG(J,L),
C     FICIRR(J,L),CON(J,L),HED(J,L),OPT(J,L) ,STRKP(L) AND PREM(L)
C     SENSITIVITY ANALYSIS INVOLVING CHANGES IN THE ABOVE
C     SPECIFIED VARIABLES IS DONE TO OBSERVE THE EFFECTS
C     ON THE INCOME DISTRIBUTION OF THE 16 RISK MANAGEMENT SCENARIOS.
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
      DIMENSION Y(17,4,4),YIELD(4,4),ECP(5),AHNP(5),AONP(5),TCP(4,4)
      DIMENSION CPP(15),CICP(15,4),FCP(5),FUPP(5),BASIS(15,5),COMM(5)
      DIMENSION CIFP(15,4),COP(4,4),ACREA(4),ACREB(4),FICIRR(4,4)
      DIMENSION CIRRG(4,4),TPROD(5,5),GREV(5,5),CONREV(5,5),CON(5,5)
      DIMENSION CODIFF(5,5),ADIFF(5,5),HEDREV(5,5),HED(5,5),HEDIFF(5,5)
      DIMENSION BDIFF(5,5),OPDIFF(5,5),OPT(5,5),OPTREV(5,5),CDIFF(5,5)
      DIMENSION STRKP(5),PREM(5)
      REAL IRRG(17,4,4),IRRIGA(4,4),NREV(5,5),INCOME(1000,16)
C     READ IN SIMULATED YIELDS OVER 17 YEARS FOR THE 4 PRODUCTION
C     ALTERNATIVES AND 4 CROPS.
      DO 20 L=1,4
      READ(5,1)((Y(I,J,L),J=1,4),I=1,17)
1     FORMAT(4F8.2)
20    CONTINUE
C     THIS READS IN THE IRRIGATION WATER USE OVER 17 YEARS,4 PRODUCTION
C     ALTERNATIVES AND 4 CROPS.
      DO 30 L=1,4
      READ(5,2)((IRRG(I,J,L),J=1,4),I=1,17)
2     FORMAT(4F8.2)
30    CONTINUE
```

```
C     READ IN THE SIZES OF LAND DEVOTED TO THE FOUR CROPS FOR THE TYPICAL
C     FARM IN NORTH FLORIDA.
      READ(5,3)(ACREA(L),L=1,4)
3     FORMAT(4F5.1)
C     READ IN THE SIZES OF THE IRRIGATED CROPS FOR THE WHOLE FARM
      READ(5,137)(ACREB(L),L=1,4)
137   FORMAT(4F5.1)
C     READ IN THE QUANTITIES OF THE 4 CROPS THAT ARE TO BE FORWARD-
C     CONTRACTED.
      DO 105 J=1,4
      READ(5,13)(CON(J,L),L=1,4)
13    FORMAT(4F12.1)
105   CONTINUE
C     READ IN THE QUANTITIES OF THE 4 CROPS TO BE HEDGED
      DO 115 J=1,4
      READ(5,14)(HED(J,L),L=1,4)
14    FORMAT(4F12.1)
115   CONTINUE
C     READ IN THE QUANTITIES TO BE SOLD UNDER THE AGRICULTURAL OPTIONS
C     SCHEME FOR THE 4 CROPS
      DO 125 J=1,4
      READ(5,15)(OPT(J,L),L=1,4)
15    FORMAT(4F12.1)
125   CONTINUE
C     READ IN THE COSTS OF PRODUCTION PER ACRE FOR THE 4 PRODUCTION
C     ALTERNATIVES AND THE 4 CROPS.
      DO 55 J=1,4
       READ(5,12)(COP(J,L),L=1,4)
12    FORMAT(4F8.2)
55    CONTINUE
C     READ IN THE VARIABLE COSTS OF IRRIGATION PER ACRE-INCH FOR THE 4
C     PRODUCTION ALTERNATIVES AND THE 4 CROPS
        DO 83 J=1,4
      READ(5,73)(CIRRG(J,L),L=1,4)
73    FORMAT(4F8.2)
83    CONTINUE
C     READ IN THE ANNUAL FIXED COSTS OF IRRIGATION PER ACRE
C     FOR THE 4 PRODUCTION ALTERNATIVES AND THE 4 CROPS GIVEN
C     THE REGULAR PRESSURE CENTER-PIVOT SYSTEM. THE CENTER PIVOT SYSTEM
C     IS CAPABLE OF IRRIGATING 138 ACRES OF CROPLAND
      DO 133 J=1,4
      READ(5,286)(FICIRR(J,L),L=1,4)
286   FORMAT(4F8.2)
133   CONTINUE
C     READ IN CASH PRICES AT PLANTING TIMES FOR THE 4 CROPS IN REFERENCE
C     YEAR(1984).
      READ(5,4)(CPP(L),L=1,4)
4     FORMAT(4F8.4)
C     READ IN FORWARD CONTRACT PRICES AT PLANTING FOR THE 4 CROPS IN 1984
      READ(5,6)(FCP(L),L=1,4)
6     FORMAT(4F8.4)
C     READ IN FUTURES PRICES AT PLANTING TIME FOR THE 4 CROPS IN 1984
      READ(5,7)(FUPP(L),L=1,4)
7     FORMAT(4F8.4)
```

```
C     READ THE COMMISSION AND THE BROKERAGE FEES PER BUSHEL OF THE 4 CROPS
C      FOR 1984
      READ(5,9)(COMM(L),L=1,4)
9     FORMAT(4F8.4)
C     READ IN THE PREMIUMS CORRESPONDING TO THE STRIKE PRICES
C     UNDER THE AGRICULTURAL FUTURES OPTIONS SCHEME FOR THE 4 CROPS
      READ(5,11)(PREM(L),L=1,4)
11    FORMAT(4F8.4)
C     READ IN THE STRIKE PRICES FOR THE OPTIONS MARKETING ALTERNATIVE
C     FOR THE 4 CROPS
      READ(5,234)(STRKP(L),L=1,4)
234   FORMAT(4F8.4)
C     READ IN CHANGE IN CASH PRICES BETWEEN PLANTING AND HARVEST FOR
C     THE 4 CROPS BETWEEN 1970 TO 1984.
      DO 40 I=1,15
      READ(5,5)(CICP(I,L),L=1,4)
5     FORMAT(4F8.4)
40    CONTINUE
C     READ IN THE CHANGE IN FUTURES PRICES BETWEEN PLANTING AND
C     HARVESTING TIMES FOR THE 4 CROPS FOR THE 15 YEARS
      DO 51 I=1,15
      READ(5,10)(CIFP(I,L),L=1,4)
10    FORMAT(4F8.4)
51    CONTINUE
C     READ IN THE BASIS FOR THE 4 CROPS IN THE TEN YEARS PERIOD.
C     THE BASIS IS DEFINED AS THE FUTURES PRICE MINUS LOCAL CASH PRICE.
C     AT A GIVEN PERIOD IN TIME.
      DO 50 I=1,15
      READ(5,8)(BASIS(I,L),L=1,4)
8     FORMAT(4F8.4)
50    CONTINUE
C     RANDOMLY CHOOSE ONE YEAR'S SIMULATED YIELD FOR THE FOUR CROPS FOR
C     THE FOUR PRODUCTION ALTERNATIVES. DO THE SAME FOR IRRIGATION WATER USE
C     REPEAT THE ENTIRE YIELD AND INCOME CALCULATION PROCESS 500 TIMES
      A=1.0
      B=17.0
      CALL RSEED(A)
      DO 60 ITEM=1,500
      XNUM=RNDMF(B)
      I=INT(XNUM)+1
      DO 70 J=1,4
        DO 70 L=1,4
       IRRIGA(J,L)=IRRG(I,J,L)
70    YIELD(J,L)=Y(I,J,L)
      CALL MARKET(CPP,CICP,L,FUPP,BASIS,STRKP,COMM,CIFP,PREM,ECP,
     $AHNP,AONP)
C     CALCULATE THE NET INCOME FOR THE FARM FOR EACH OF THE 16 SCENARIOS.
C
C     CALCULATE THE NET INCOME FOR THE 4 SCENARIOS INVOLVING THE FOLLOWING
C     MARKETING STRATEGY---CASH SALES AT HARVEST TIMES ONLY.
      INC=0
      DO 999 J=1,4
      INC=INC+1
      INCOME(ITEM,INC)=0
      DO 999 L=1,4
      TPROD(J,L)=YIELD(J,L)*ACREA(L)
      TCP(J,L)=(COP(J,L)*ACREA(L))+(IRRIGA(J,L)*CIRRG(J,L)*ACREB(L))
     $+(FICIRR(J,L)*ACREB(L))
      GREV(J,L)=TPROD(J,L)*ECP(L)
      NREV(J,L)=GREV(J,L)-TCP(J,L)
      INCOME(ITEM,INC)=INCOME(ITEM,INC)+NREV(J,L)
999   CONTINUE
C     THE NEXT STATEMENTS CALCULATE THE NET INCOME OF THE FARM FOR THE
C     4 RISK MANAGEMENT SCENARIOS INVOLVING THE FORWARD CONTRACTING
C     MARKETING ALTERNATIVE
      DO 998 J=1,4
      INC=INC+1
      INCOME(ITEM,INC)=0
      DO 998 L=1,4
      CODIFF(J,L)=TPROD(J,L)-CON(J,L)
      CONREV(J,L)=CON(J,L)*FCP(L)
      ADIFF(J,L)=CODIFF(J,L)*ECP(L)
      GREV(J,L)=CONREV(J,L)+ADIFF(J,L)
      NREV(J,L)=GREV(J,L)-TCP(J,L)
      INCOME(ITEM,INC)=INCOME(ITEM,INC)+NREV(J,L)
998   CONTINUE
C     THE NEXT STATEMENTS CALCULATE THE NET INCOME OF THE FARM FOR THE
C     4 RISK MANAGEMENT SCENARIOS INVOLVING THE HEDGING MARKETING
C     ALTERNATIVE
      DO 997 J=1,4
      INC=INC+1
      INCOME(ITEM,INC)=0
      DO 997 L=1,4
      HEDIFF(J,L)=TPROD(J,L)-HED(J,L)
      HEDREV(J,L)=HED(J,L)*AHNP(L)
      BDIFF(J,L)=HEDIFF(J,L)*ECP(L)
      GREV(J,L)=HEDREV(J,L)+BDIFF(J,L)
      NREV(J,L)=GREV(J,L)-TCP(J,L)
      INCOME(ITEM,INC)=INCOME(ITEM,INC)+NREV(J,L)
997   CONTINUE
C     THE NEXT STATEMENTS CALCULATE THE NET INCOME OF THE FARM FOR THE
C     4 RISK MANAGEMENT SCENARIOS INVOLVING THE AGRICULTURAL OPTIONS
C     MARKETING ALTERNATIVE
      DO 996 J=1,4
      INC=INC+1
      INCOME(ITEM,INC)=0
      DO 996 L=1,4
      OPDIFF(J,L)=TPROD(J,L)-OPT(J,L)
      OPTREV(J,L)=OPT(J,L)*AONP(L)
      CDIFF(J,L)=OPDIFF(J,L)*ECP(L)
      GREV(J,L)=OPTREV(J,L)+CDIFF(J,L)
      NREV(J,L)=GREV(J,L)-TCP(J,L)
      INCOME(ITEM,INC)=INCOME(ITEM,INC)+NREV(J,L)
996   CONTINUE
60    CONTINUE
      DO 120 N=1,16
      WRITE(10,140) N
120   WRITE(10,130)(INCOME(M,N),M=1,500)
```

```
130   FORMAT(100(5F12.4/))
140   FORMAT(' SCENARIO ',I2)
      STOP
      END
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
      SUBROUTINE MARKET(CPP,CICP,L,FUPP,BASIS,STRKP,COMM,CIFP,PREM,
     $ECP,AHNP,AONP)
      REAL CPP(15),CICP(15,4),FUPP(4),BASIS(15,4),COMM(4),CIFP(15,4),
     $PREM(4),ECP(4),AHNP(4),AONP(4),STRKP(4)
      A=123.00
      B=15.0
      YNUM=RNDMF(B)
      NUM=INT(YNUM)+1
      DO 75 L=1,4
      ECP(L)=CPP(L)+CICP(NUM,L)
      AHNP(L)=FUPP(L)-BASIS(NUM,L)-COMM(L)
      IF (FUPP(L)+CIFP(NUM,L)-STRKP(L).GT.0) THEN DO
C     DO NOT EXERCISE THE FUTURES PUT OPTION THAT YOU HAVE BOUGHT
      AONP(L)=(FUPP(L)+CIFP(NUM,L))-PREM(L)-COMM(L)
     $-BASIS(NUM,L)
      ENDIF
      IF(FUPP(L)+CIFP(NUM,L)-STRKP(L).LE.0) THEN DO
C     EXERCISE THE FUTURES PUT OPTION THAT YOU HAVE BOUGHT
      AONP(L)=STRKP(L)-PREM(L)-COMM(L)-BASIS(NUM,L)
      ENDIF
75    CONTINUE
      RETURN
      END
C     THIS LINE ENDS THE INCOME PROGRAM. WE ARE READY FOR THE
C     EXECUTION OF THE PROGRAM.
C     THE RESULTS OF THE 'INCOME' PROGRAM ARE LISTED BELOW
C     IN  DOLLARS.
$ENTRY
//INCLUDE INCDATA
//GO.FT10F001 DD UNIT=SYSDA,DSN=UF.D0011288.S1.INCOUTS,
//  DISP=(NEW,CATLG,DELETE),SPACE=(TRK,(5,10)),
//  DCB=(RECFM=FB,LRECL=80,BLKSIZE=6160)
```

# APPENDIX I
# THE STOCHASTIC DOMINANCE WITH RESPECT TO A FUNCTION PROGRAM IN FORTRAN

```
C-  THIS PROGRAM COMPARES PROBABILITY DISTRIBUTIONS FOR DIFFERENT
C-  CLASSES OF RISK AVERTERS(AND PREFERRERS). IT IS BASED ON AN
C-  ARTICLE BY JACK MEYER,"CHOICE AMONG DISTRIBUTIONS",JOURNAL OF
C-  ECONOMIC THEORY,1977,PP.326-336. FOR AN EXAMPLE OF APPLICATION
C-  SEE JACK MEYER," FURTHER APPLICATIONS OF STOCHASTIC DOMINANCE
C-  TO MUTUAL FUND PERFORMANCE", JOURNAL OF FINANCIAL AND QUANTITATIVE
C-  ANALYSIS, JUNE 1977,PP.235-242.
C-
C- THE PROGRAM WAS WRITTEN BY JACK MEYER IN 1977, MODIFIED SLIGHTLY
C- BY RANDY KRAMER IN 1980 AND LATER BY KWABENA ANAMAN IN 1984 FOR USE
C- WITH NORTH FLORIDA FARM DATA.  THE LATEST MODIFICATIONS HAVE BEEN
C- ADDED TO ALLOW ALL POSSIBLE PAIRWISE COMPARISONS OF THE DISTRIBUTIONS
C- TO BE DONE TO TEST FOR STOCHASTIC DOMINANCE. TWO MORE PARAMETERS OF THE
C- DATA POINTS HAVE BEEN ESTIMATED. THEY ARE THE COEFFICIENT OF VARIATION
C- AND THE PROBABILITY OF THE FARMER OR THE PRODUCER RECEIVING LESS THAN
C- THE CRITICAL INCOME(PNI).  THE CRITICAL INCOME COULD BE ZERO
C- OR ANY LEVEL CHOSEN BY THE RESEARCHER.
C- THE MAXIMUM NUMBER OF PROBABILITY DISTRIBUTIONS THAT CAN BE COMPARED
C- IS 65 WHILE THE MAXIMUM NUMBER OF DATA POINTS IN EACH DISTRIBUTION
C- IS 500. BOTH MAXIMUM VALUES MAYBE INCREASED BY CHANGING THE
C- COMMON STATEMENTS AND ENLARGING THE MEMORY SPACE FOR THE PROGRAM.
C- TWELVE UTILITY GROUPS OF FARMERS ARE USED IN THE STUDY.
C-
C-  AN EXEC FOR RUNNING THIS INTERACTIVELY ON AN IBM COMPUTER FOLLOWS:
C-  FILEDEF 08 DISK PEST  DATA
C-  FILEDEF 06 DISK MEYEROUT DATA
C-  FILEDEF 05 DISK TEST DATA
C-  GLOBAL TXTLIB FORTXLIB
C-  LOAD MEYER100
C-  START
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
        IMPLICIT REAL*8(A-H,O-Z)
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
C-  DIMENSIONS ARRAYS IN COMMON
      DIMENSION ICODE(65,3),NSD(12),CE1(65,1000),CE2(65,1000),NAME(65,6)
      DIMENSION CCP(1000)
C-  DIMENSIONS ARRAYS NOT IN COMMON
      NE=16
C-  NE IS NUMBER OF DISTRIBUTIONS TO BE COMPARED
      CN=0.0
C- CN IS THE CRITICAL INCOME LEVEL SPECIFIED BY THE FARMER
      ND=500
C-  ND IS NUMBER OF DATA POINTS ON EACH DISTRIBUTION
      NG=12
C-  NG IS NUMBER OF UTILITY GROUPS
      WRITE(6,300)
C- WRITES HEADINGS
 300  FORMAT(1H1,4X,4HNAME,15X,11HDATA POINTS,/,69X,
     $4HMEAN,11X,3HSTD,11X,2HCV,7X,3HPNI)
      DO 100 I=1,NE
      READ(10,200) (NAME(I,J),J=1,6),(R(I,J),J=1,ND)
C- FOR EACH DISTRIBUTION READS NAME AND DATA POINTS
 200  FORMAT(6A4,/,100(5F12.4,/))
```

```
      VAR=0.0
      AMEAN=0.0
      BND=ND
      TNI=0.0
      DO 101 J=1,ND
C- INITIALIZES VARIANCE AND MEAN
      AMEAN=AMEAN+(1.0/BND)*R(I,J)
       VAR=VAR+(1.0/BND)*R(I,J)*R(I,J)
C- CALCULATES MEAN AND VARIANCE
      T(J)=R(I,J)
      IF(R(I,J).LT.CN) TNI=TNI+1.0
C- PUTS DATA IN ARRAY T FOR FUTURE SORTING
 0101 CONTINUE
      VAR=VAR-AMEAN*AMEAN
      STD=DSQRT(VAR)
      CV=STD/AMEAN
      PNI=TNI/ND
C- COMPUTES STANDARD DEVIATION AND COEFFICIENT OF VARIATION
      WRITE(6,301) (NAME(I,J),J=1,6 ),(R(I,J),J=1,ND),AMEAN,STD,CV
     $,PNI
C- WRITES DATA POINTS,MEAN,STANDARD DEVIATION,COEFFICIENT OF
C- VARIATION AND PROBABILITY OF NOT RECEIVING THE CRITICAL INCOME
0301  FORMAT(1H0,6A4,/,100(5F12.4,/),/,65X,F12.4,1X,F12.4,1X,F12.4,2X,
     $F8.4)
  700 FORMAT(6A4,100(5F12.4,/))
      CALL RORDER
C- ORDERS ARRAY T
      DO 102 J=1,ND
      R(I,J)=T(J)
C- PUTS ORDERED DATA BACK IN R
 0102 CONTINUE
 0100 CONTINUE
      WRITE(6,305)
 0305 FORMAT(1H1)
C- SKIPS A PAGE
      DO 103 I=1,NG
      READ(5,201) (RA(I,J),J=1,2)
C- READS PARAMETERS OF EACH RISK AVERSION GROUP
 0201 FORMAT(2F12.5)
      WRITE(6,302) I,(RA(I,J),J=1,2)
C- WRITES PARAMETERS OF EACH RISK AVERSION GROUP
 0302 FORMAT(1H0,5HGROUP,I4,15H PARAMETERS ARE,2F12.5)
      DO 104 J=1,NE
      B1=0.0
      B2=0.0
      DO 105 K=1,ND
      B1=B1+(1.0/BND)*U1(R(J,K),I)
      B2=B2+(1.0/BND)*U2(R(J,K),I)
C- FOR EACH DISTRIBUTION INITIALIZES AND CALCULATES EXPECTED
C- UTILITY OF DISTRIBUTION FOR LOWER AND UPPER BOUND  U FUNCTIONS
 0105 CONTINUE
      CE1(J,I)=UI1(B1,I)
      CE2(J,I)=UI2(B2,I)
C- USES U INVERSE TO FIND THE CERTAINTY EQUIVALENTS
```

```
 0104 CONTINUE
 0103 CONTINUE
      WRITE(6,303)
 0303 FORMAT(1H1,6X,4HNAME,8X,6HVERSUS,10X,4HNAME,50X,6HGROUPS)
C- WRITES HEADINGS
      DO 997 L=1,NE
      DO 115 I=L,L
C- THIS LOOP COMPARES DISTRIBUTION #L WITH ALL OTHERS
C- MOVES THE INDEX UP ONE
      DO 106 J=1,NE
      IF(J.EQ.L) GO TO 106
      DO 107 K=1,NG
C- RUNS THROUGH ALL THE DISTRIBUTIONS DOWN THE LIST FROM THE FIRST
C- ONE
      IF(CE1(I,K) .GE. CE1(J,K) .AND. CE2(I,K) .GE. CE2(J,K))GO TO 60
C- IF BOTH CE ARE BIGGER FOR I THAN J FROM RISK AVERSE GROUP K
      IF(CE1(I,K) .LE. CE1(J,K) .AND. CE2(I,K) .LE. CE2(J,K))GO TO 61
C- IF BOTH CE ARE LESS FOR I THAN J FROM RISK AVERSE GROUP K
      NSD(K)=0
C- IF NEITHER OF THE ABOVE ARE TRUE THAN IT MUST BE THAT
C- THERE IS NO STOCHASTIC DOMINANCE OF I OVER J OR J OVER I
      GO TO 107
 0060 CALL CUMCAL(J,I)
C- CE'S BIGGER FOR I THAN J SO FORM DIFFERENCE J-I
      CALL SD(EU,K)
C- CHECK IF I DOMINATES J BY FINDING MU
      IF(EU .GE. 0.0) GO TO 62
C- IF DOMINATES GO TO 62
      IF(CE1(I,K) .EQ. CE1(J,K) .AND. CE2(I,K) .EQ. CE2(J,K))GO TO 61
C- IF DOES NOT DOMINATE CHECK IF CE'S ARE EQUAL TO SEE IF J
C- DOMINATES
      NSD(K)=0
C- IF NOT THERE IS NO DOMINANCE
      GO TO 107
 0062 NSD(K)=1
      GO TO 107
 0061 CALL CUMCAL(I,J)
C- CE'S BIGGER FOR J THAN I SO FORM I-J
      CALL SD(EU,K)
C- CHECK SD BY FINDING MU
      IF(EU .GE. 0.0) GO TO 63
C- IF DOMINATES GO TO 63
      NSD(K)=0
C- IF NOT DOMINATED SET NSD=0
      GO TO 107
 0063 NSD(K)=-1
C- IF DOMINATES SET NSD=-1
 0107 CONTINUE
      WRITE(6,304) (NAME(I,K),K=1,6),(NAME(J,K),K=1,6),(NSD(K),K=1,NG)
C- WRITES NAMES OF I,J,AND WHETHER I DOMINATES J (+1), NEITHER
C- DOMINATES (0), OR J DOMINATES I (1) FOR EACH UTILITY GROUP K
 0304 FORMAT(1H ,4X,6A4,4X,6A4,12I6)
 0106 CONTINUE
 0115 CONTINUE
```

```
      WRITE(6,993)
993   FORMAT(1H0)
997   CONTINUE
      STOP
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      FUNCTION U1(X,JJ)
      IMPLICIT REAL*8(A-H,O-Z)
C- THIS FORMS LOWER BOUND FUNCTION WHICH DEFINES CONSTANT RISK
C- AVERSE UTILITY FUNCTION: EXP8-RX!, X, EXP3RX! DEPENDING ON
C- SIGN OF R.
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      DL=-RA(JJ,1)*X
      IF(RA(JJ,1))92,91,90
 0090 U1=-DEXP(DL)
      GO TO 93
 0091 U1=X
      GO TO 93
 0092 U1=DEXP(DL)
 0093 RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      FUNCTION U2(X,JJ)
      IMPLICIT REAL*8(A-H,O-Z)
C- FORMS UPPER BOUND FUNCTION SAME AS ABOVE
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      DM=-RA(JJ,2)*X
      IF(RA(JJ,2)) 82,81,80
 0080 U2=-DEXP(DM)
      GO TO 83
 0081 U2=X
      GO TO 83
 0082 U2=DEXP(DM)
 0083 RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      FUNCTION UI1(X,JJ)
      IMPLICIT REAL*8(A-H,O-Z)
C- THIS FORMS INVERSE OF U1
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      IF(RA(JJ,1)) 72,71,70
 0070 UI1=-DLOG(-X)/RA(JJ,1)
      GO TO 73
 0071 UI1=X
      GO TO 73
 0072 UI1=-DLOG(X)/RA(JJ,1)
 0073 RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
      FUNCTION UI2(X,JJ)
      IMPLICIT REAL*8(A-H,O-Z)
C- THIS FORMS INVERSE OF U2
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      IF(RA(JJ,2))62,61,60
 0060 UI2=-DLOG(-X)/RA(JJ,2)
      GO TO 63
 0061 UI2=X
      GO TO 63
 0062 UI2=-DLOG(X)/RA(JJ,2)
 0063 RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      SUBROUTINE RORDER
       IMPLICIT REAL*8(A-H,O-Z)
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      ND1=ND-1
      DO 400 I=1,ND1
      AM=T(I)
      N=I
      I1=I+1
      DO 401 J=I1,ND
      IF(AM .LE. T(J))GO TO 401
      N=J
      AM=T(J)
 0401 CONTINUE
      T(N)=T(I)
      T(I)=AM
 0400 CONTINUE
      RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      SUBROUTINE CUMCAL(M1,M2)
       IMPLICIT REAL*8(A-H,O-Z)
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      K1=1
      K2=1
      C(1)=0.0
      CP(1)=0.0
      BND=ND
      ND2=ND*2+1
      DO 500 I=2,ND2
      IF(K1 .GT. ND .AND. K2 .GT. ND)GO TO 550
      IF(K1 .GT. ND)GO TO 553
      IF(K2 .GT. ND)GO TO 551
      IF(R(M1,K1)-R(M2,K2)) 551,552,553
 0551 C(I)=C(I-1)+(1.0/BND)
      CP(I)=R(M1,K1)
      K1=K1+1
      GO TO 500
 0552 C(I)=C(I$1)
      CP(I)=R(M1,K1)
      K1=K1+1
      K2=K2+1
      GO TO 500
 0553 C(I)=C(I-1)-(1.0/BND)
      CP(I)=R(M2,K2)
      K2=K2+1
      GO TO 500
 0550 C(I)=0.0
      CP(I)=0.0
 0500 CONTINUE
      RETURN
      END
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C-%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
      SUBROUTINE SD(MU,II)
       IMPLICIT REAL*8(A-H,O-Z)
      COMMON ND,NE,NG,C(1000),CP(1000),T(1000),R(50,1000),RA(12,4)
      EXTERNAL U1,U2
      REAL MU
      MU=0.0
      NL=2*ND
      ND2=2*ND
      DO 600 I=1,ND2
      IF(NL .LE. 1)GO TO 650
      IF(C(NL)) 651,652,653
 0652 NL=NL-1
      MU=0.0
      GO TO 600
 0653 MU=MU+(U2(CP(NL+1),II)-U2(CP(NL),II))*C(NL)
      NL=NL-1
      DO 601 J=1,ND2
      IF(NL .LE. 1)GO TO 650
      TU=(U2(CP(NL+1),II)-U2(CP(NL),II))*C(NL)
      IF(MU+TU) 654,652,655
 0655 MU=MU+TU
      NL=NL-1
 0601 CONTINUE
 0654 TT=MU/C(NL)+U2(CP(NL+1),II)
      Q=UI2(TT,II)
      MU=0.0
      CP(NL+1)=Q
      GO TO 600
 0651 MU=MU+(U1(CP(NL+1),II)-U1(CP(NL),II))*C(NL)
      NL=NL-1
      DO 602 K=1,ND2
      IF(NL .LE. 1)GO TO 650
      TU=(U1(CP(NL+1),II)-U1(CP(NL),II))*C(NL)
      IF(MU+TU) 656,652,657
 0656 MU=MU+TU
      NL=NL-1
 0602 CONTINUE
 0657 TS=MU/C(NL)+U1(CP(NL+1),II)
      Q=UI1(TS,II)
      MU=0.0
      CP(NL+1)=Q
 0600 CONTINUE
 0650 RETURN
      END
//GO.FT10F001 DD UNIT=SYSDA,DSN='UF.D0011288.S1.INCOUTS',DISP=OLD
//GO.SYSIN DD *
/*INCLUDE ARACDATA
/*
```

# REFERENCES CITED

Abassa, K. P. 1984. "Systems Approach to Gobra Zebu Production in Dahra, Senegal." Ph.D. dissertation, Animal Science Department, University of Florida, Gainesville, Florida.

Agricultural and Credit Outlook. 1983. Farm Credit Administration, Washington, D.C.

"Agricultural Report: 93,000 Farms on Verge of Going Broke." 1985. Gainesville Sun, March 11 Edition, page 3b.

Allais, M., and O. Hagen. 1979. Expected Utility Hypothesis and the Allais Paradox: Contemporary Discussion of Decisions under Uncertainty with Allais Rejoinder. D. Reidel, Dordrecht, Holland.

Anaman, Kwabena A. 1981. "Optimal Irrigation Strategies for the Valencia Citrus in Florida." Master's Thesis, University of Florida, Gainesville, Florida.

Anderson, J. R., J. L. Dillon and B. Hardaker. 1977. Agricultural Decision Analysis. Iowa State University Press, Ames, Iowa.

Antle, J. M. 1983. "Sequential Decision Making in Production Models," American Journal of Agricultural Economics 65(2):282-290.

Barnett, D., B. Blake and B. A. McCarl. 1982. "Goal Programming via Multi-dimensional Scaling Applied to Senegalese Subsistence Farmers," American Journal of Agricultural Economics 65(4): 720-727.

Barry, P. J. 1983. "Financing Growth and Adjustments of Farm Firms under Risk and Inflation: Implications for Micromodeling." In K. H. Baum and L. P. Schertz (editors), Modeling Farm Decisions for Policy Analysis. Westview Press, Boulder, Colorado, pp. 111-134.

Berck, P., and J. M. Hihn. 1982. "Using Semi-Variance to Estimate Safety-First Rules," American Journal of Agricultural Economics 64(2):298-300.

Boggess, W. G., and C. B. Amerling. 1983. "A Bioeconomic Simulation Analysis of Irrigation Investments," Southern Journal of Agricultural Economics 15(2):85-91.

Borch, K. H. 1968. The Economics of Uncertainty. Princeton University Press, Princeton, New Jersey, Chapter 6.

Boussard, J. M., and M. Petit. 1967. "Representation of Farmers' Behavior under Uncertainty with a Focus-Loss Constraint." Journal of Farm Economics 49(4):869-880.

Brooke, D. L. 1978. Florida Farm Prices. Economic Information Report 89, Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Buhlman, Hans. 1970. Mathematical Methods in Risk Theory. Springer-Verling, New York.

Catania, P. J., J. R. Polt and J. J. Ware. 1984. Agricultural Options: A Primer for Producers. Doane Publishing Press, St. Louis, Missouri.

Church, G. J., S. Allis and G. Bolte. 1985. "Real Trouble on the Farm." Time Magazine February 18:24-31, United States Edition.

Cochrane, M., W. Lodwick and R. Raskin. 1984. "The Implementation of Convex Set Stochastic Dominance for Applied Risk Analysis," Risk Analysis for Agricultural Production Firms: Concepts, Information Requirements and Policy Issues. Proceedings of a Seminar Sponsored by Southern Regional Risk Project S-180, New Orleans, Louisiana, March 25-28.

Csaki, Csaba. 1985. Simulation and Systems Analysis in Agriculture. Akademiai Kiado, The Publishing House of the Hungarian Academy of Sciences, Budapest, Hungary, and Elsevier Science Publishers, Amsterdam, The Netherlands.

d'Almada, P. J., G. D. Lynne and A. G. Smajstrla. 1985. A User's Manual for the Farm Laboratory Irrigation Cost Generator: Interactive Version. Economic Information Report, Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Dalton, J. F., and F. Bailey. 1984. A Guide To: Options Strategies for the Farm Business. J. F. Dalton Associates, Chicago, Illinois.

de Janvry, A. 1972. "Optimal Levels of Fertilization under Risk: The Potential for Corn and Wheat Fertilization under Alternative Price Policies in Argentina," American Journal of Agricultural Economics 54:1-10.

Dent, J. B., and M. J. Blackie. 1979. Systems Simulation in Agriculture. Applied Science Publishers, London, Great Britain.

Dillon, J. L. 1977. The Analysis of Response in Crop and Livestock Production, second edition. Pergamon Press, New York.

Duncan, W. G. 1976a. "Penutz Dictionary." Unpublished paper, Department of Agronomy, University of Florida, Gainesville, Florida.

Duncan, W. G. 1976b. "Simiaz Dictionary." Unpublished paper, Department of Agronomy, University of Florida, Gainesville, Florida.

Ehrenberg, A. S. C. 1972. Repeat Buying - Theory and Applications. North Holland Publishing Company, Amsterdam, Holland.

Eidman, V. R. (editor). 1971. Agricultural Production Systems Simulation. Proceedings of Southern Farm Management Research Committee Workshop, Stillwater, Oklahoma.

English, M. J., and G. T. Orlob. 1978. Decision Theory Applications and Irrigation Optimization. California Water Resources Center, University of California Contribution No. 174, September.

"(The) Farmers' Fight Against Foreclosures." 1983. Newsweek February 7:56-59.

Feder, G., R. E. Just and A. Schmitz. 1980. "Futures Market and Theory of the Firm under Price Uncertainty," The Quarterly Journal of Economics 94(2):317-328.

Flood, M., F. McCamley and K. Schneeberger. 1985a. The Relative Effectiveness of Third Degree Stochastic Dominance, Decreasing Absolute Risk Aversion Stochastic Dominance and Stochastic Dominance with Respect to a Function as Methods for Analyzing Alternative Crop Varieties. Paper presented at the Annual Meeting of the Southern Agricultural Economics Association, Biloxi, Mississippi.

Flood, M., F. McCamley and K. Schneeberger. 1985b. Restricted Absolute Risk-Aversion Stochastic Dominance. Paper submitted to the Selected Papers Committee for the 1985 Annual Meeting of the American Agricultural Economics Association.

Georgia Crop Reporting Service. Georgia Agricultural Facts. Various Issues from 1970 to 1978.

Gould, J. P., and C. E. Ferguson. 1980. Micro-economic Theory, fifth edition. Richard D. Irwin, Inc., Homewood, Illinois.

Greene, R. E. L., K. Mathis, L. Polopolus and J. Holt. 1980. Economic Data for Florida Agriculture, 1975-1980. Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Hadar, J., and W. R. Russell. 1974. "Stochastic Dominance in Choice under Uncertainty." In M. Balch and D. McFadden (editors), Essays on Economic Behavior under Uncertainty. North Holland, Amsterdam, pp. 133-150.

Hanson, V. E., O. W. Israelsen and G. E. Stringham. 1984. "Production, Price and Risk Factors in Channel Catfish Farming," Southern Journal of Agricultural Economics 16(1):173-182.

Hazell, P. B. R. 1982. "Application of Risk Preference Estimates in Firm-Household and Agricultural Sector Models," American Journal of Agricultural Economics 64(2):384-390.

Herath, H. M. G., J. B. Hardaker and J. R. Anderson. 1982. "Choice of Varieties by Sri-Lanka Rice Farmers: Comparing Alternative Decision Models," American Journal of Agricultural Economics 64(1):87-93.

Hewitt, T. 1984. Estimated Costs of Producing Selected Crops in North Florida for 1984. Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Hillier, F. S., and G. J. Lieberman. 1980. Introduction to Operations Research, third edition. Holden-Day, Inc., San Francisco, California.

Johnston, J. 1984. Econometric Methods, third edition. McGraw-Hill Book Company, New York.

Kiker, C. F., and E. Bauman. 1984. "Producer Gas Fueled Irrigation: Evaluating the Potential of a Technology," Southern Journal of Agricultural Economics 16(22):127-134.

King, R. P., and G. E. Oamek. 1983. "Risk Management by Colorado Dryland Wheat Farmers and the Elimination of the Disaster Assistance Program," American Journal of Agricultural Economics 65(2):247-255.

King, R. P., and J. Robison. 1981. Implementation of the Interval Approach to the Measurement of Decision Maker Preferences. Research Report 418, Agricultural Business, Michigan State University, East Lansing, Michigan.

Knight, F. H. 1922. Risk, Uncertainty, and Profit. Houghton Mifflin, Boston, Massachusetts.

Kramer, R. A., and R. D. Pope. 1981. "Participation in Farm Commodity Programs: A Stochastic Dominance Analysis," American Journal of Agricultural Economics 63(1):119-128.

Kroll, Y., and H. Levy. 1980. "Sampling Errors and Portfolio Efficient Analysis." Journal of Financial and Quantitative Analysis 15:655-689.

Love, R. O., and L. J. Robison. 1984. "An Empirical Analysis on the Intertemporal Stability of Risk Preference," Southern Journal of Agricultural Economics 16(1):151-158.

Machina, M. J. 1982. "Expected Utility Analysis' without the Independence Axiom," Econometrica 2:277-323.

Machina, M. J. 1985. "Generalized Expected Utility Analysis and the Nature of Observed Violations of the Independence Axiom." Unpublished paper, Department of Economics, University of California, San Diego, California.

Marbach, W. D., W. J. Cook, T. Nater, J. Pringle, E. Ipsen and D. Shapiro. 1983. "The Unrigging of Oil Prices." Newsweek March 7:62-65.

Markowitz, H. 1978. Portfolio Selection - Efficient Diversification of Investments. John Wiley and Sons, Inc., New York.

Melton, B. E. 1978. Nutrient Requirements and Least-Cost Supplement Rations for Florida Beef Cow Herds. Staff Paper No. 106, Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Meyer, J. 1977a. "Choice Among Distributions," Journal of Economic Theory 14:326-336.

Meyer, J. 1977b. "Further Applications of Stochastic Dominance to Mutual Fund Performance." Journal of Financial and Quantitative Analysis June:235-242.

Mood, A. M., and F. A. Graybill. 1963. Introduction to the Theory of Statistics. McGraw-Hill Book Company, New York.

Morrison, D. 1967. "On the Consistency of Preferences in Allais Paradox," Behavioral Sciences 12:373-383.

Musser, W. N., F. C. White and G. S. Smith. 1984. "Current Financial Stress Among Farmers in South Georgia." Agricultural Finance Review 44:1-7.

Patrick, G. F., and B. F. Blake. 1980. "Measurement of Modeling of Farmers' Goals: An Evaluation and Suggestions," Southern Journal of Agricultural Economics 12(1):199-204.

Pope, R. D., and R. F. Ziemer. 1984. "Stochastic Efficiency, Normality, and Sampling Errors in Agricultural Risk Analysis," American Journal of Agricultural Economics 66(1):31-40.

Pratt, J. W. 1964. "Risk Aversion in the Small and in the Large," Econometrica 32:122-136.

Raiffa, H. 1968. Decision Analysis: Introductory Lectures in Choice under Uncertainty. Addison-Wesley, Reading, Massachusetts.

Rister, M. E., J. R. Skees and J. R. Black. 1984. "Evaluating Use of Outlook Information in Grain Sorghum Storage Decisions," Southern Journal of Agricultural Economics 16(1):151-158.

Robison, L. J., and B. Fleisher. 1983. "Risk: Can We Model What We Cannot Define?" Unpublished paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

Sandmo, A. 1971. "On the Theory of the Competitive Farm under Price Uncertainty," American Economic Review March:65-73.

SAS Institute, Inc. 1982. SAS Users Guide: Statistics, 1982 edition. SAS Institute, Inc., Cary, North Carolina, pp. 257-285.

SAS Institute, Inc. 1983. SUGI Supplemental Library Users Guide. SAS Institute, Inc., Cary, North Carolina, pp. 181-202.

Schmiesing, B. H. 1984. Two Basic Options Strategies for Producers: Buying Puts and Shorting Calls. Economics Staff Paper No. 84-3, Economics Department, South Dakota State University, Brookings, South Dakota.

Shepard, L. E., R. A. Collins. 1982. "Why Do Farmers Fail? Farm Bankruptcies, 1910-1978," American Journal of Agricultural Economics 64(4):609-615.

Theil, H. 1971. Principles of Econometrics. John Wiley and Sons, Inc., New York.

Tobin, J. 1958. "Liquidity Preferences as Behavior Towards Risk," Review of Economic Studies 25:65-86.

U.S. Department of Agriculture. Agricultural Prices. Crop Reporting Board, Economic, Statistics and Cooperatives Services, Washington, D.C., various issues.

Valencia, J. 1982. Project Appraisal under Uncertainty. Texas Instruments Calculator Products Division, PPX-59 Professional Program Exchange.

Vickson, R. G. 1977. "Stochastic Dominance Tests for Decreasing Absolute Risk Aversion II: General Random Variables," Management Science 23:478-489.

von Neumann, J., and O. Morgenstern. 1947. The Theory of Games and Economic Behavior, second edition. Princeton University Press, Princeton, New Jersey.

Wagner, H. M. 1969. *Principles of Operations Research with Applications to Managerial Decisions*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

*Wall Street Journal*. Various issues from December 1984 to February 1985.

Whitmore, G. A. 1970. "Third Degree Stochastic Dominance," *American Economic Review* 60:457-459.

Wilkerson, G. G., J. W. Mishoe, J. L. Stimac, J. W. Jones, D. P. Swaney and W. G. Boggess. 1982. *Florida Soybean Integrated Crop Management Model: Model Description and User's Guide*. University of Florida, Gainesville, Florida.

Wilson, P. N. 1982. "Structural Determinants of the Swine Production Industry: A Stochastic Dominance Anlaysis." Ph.D. dissertation, University of Minnesota.

Wilson, P. N., and V. R. Eidman. 1983. "An Empirical Test of the Interval Approach for Estimating Risk Preference," *Western Journal of Agricultural Economics* 8:170-182.

Young, D. L., W. Lin, R. Pope, L. Robison and R. Selley. 1979. "Risk Preferences of Agricultural Producers: Their Measurement and Use." In *Risk Management in Agriculture: Behavioral, Managerial, and Policy Issues*. Paper AE-4478, Illinois Agricultural Experiment Station, Urbana-Champaign, Illinois.

# OTHER WORKS CONSULTED

Alexander, V. J., W. N. Musser and G. Mason. 1985. Futures Markets and Firm Decisions under Price, Production and Financial Uncertainty. Paper presented at the Southern Agricultural Association Meetings, Biloxi, Mississippi, February 3-6.

Anaman, Kwabena A. 1977. "Some Economic Aspects of Cocoa Production in the Techiman Cocoa District of Brong-Ahafo, Ghana." Bachelor of Science Thesis, University of Ghana, Legon, Accra, Ghana.

Anaman, Kwabena A. 1982. "A Stochastic Simulation Investment Analysis of Oil Palm Project in Eastern Ghana Based on Yield Uncertainty." Unpublished paper, Department of Food and Resource Economics, University of Florida, Gainesville, Florida.

Anaman, Kwabena A., William G. Boggess and Gregory D. Hanson. 1985. Farm Risks: Their Importance, Causes and Farmers' Responses. A Survey Report of Sample Farmers in North Florida and South Alabama. Paper presented at the Southern Agricultural Economics Association Meeting, Biloxi, Mississippi, February 3-6.

Bagi, F. S. 1983. "A Logit Model of Farmers' Decisions about Credit," Southern Journal of Agricultural Economics 15(2):13-19.

Barry, P. J. 1983. "Perspectives on Risk Management Research Contributions of Regional Project W-149," Risk Management Strategies for Agricultural Production Firms: Perspectives and Research Issues. Department of Agricultural Economics, Oklahoma State University, AE-8350, May:1-6.

Barry, P. J. (editor). 1984. Risk Management in Agriculture. Iowa State University Press, Ames, Iowa.

Binswanger, H. P. 1980. Attitudes Toward Risk: Experimental Measurement in Rural India," American Journal of Agricultural Economics 62(3):395-407.

Boggess, William G., and Kwabena A. Anaman. 1984. "Farm Risks in North Florida: Importance Causes and Farmers' Responses," Florida Food and Resource Economics 60(Sept-Oct). Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Boggess, William G., and Kwabena A. Anaman. 1985. Risk Efficiency Analysis of Alternative Marketing Strategies for Mixed Crop Farms in North Florida. Paper presented at the Annual Meeting of the Southern Agricultural Management Research Information Exchange Group, University of Florida, Gainesville, May 22-24.

Brooke, D. L. 1978. Florida Farm Prices. Economic Information Report 89, Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Buccola, S. T., and A. Subaei. 1984. "Mean-Gini Analysis, Stochastic Efficiency and Weak Risk-Aversion." Unpublished paper, Oregon State University, Corvallis, Oregon.

Buhlman, Hans. 1970. Mathematical Methods in Risk Theory. Springer-Verling, New York.

Cochran, W. G., and G. M. Cox. 1964. Experimental Design, 2nd edition. John Wiley and Sons, Inc., New York.

Crawford, E. W., and R. A. Milligan. 1982. "A Multi-Year, Stochastic, Farm Simulation Model for Northern Nigeria: An Experimental Design Approach," American Journal of Agricultural Economics 64(4):728-737.

Dalton, G. E. 1982. Managing Agricultural Systems. Applied Science Publishers, London, Great Britain.

Doorenbos, J., and A. H. Kassam. 1979. Yield Response to Water. FAO Irrigation and Drainage Paper 33, Food and Agricultural Organization of the United Nations, Rome, Italy.

FARM Systems Laboratory. 1984. "Costs and Returns Budgets for Corn, Peanuts, and Soybeans in Florida." Unpublished reports, Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Friedrich, K. H. 1977. Farm Management Data Collection and Analysis: An Electronic Data Processing Storage and Retrieval System. Food and Agricultural Organization of the United Nationa, Rome, Italy.

Garcia, P., R. M. Leuthold and M. E. Sarhan. 1984. "Basis Risk: Measurement and Analysis of Basis Fluctuations for Selected Livestock Markets," American Journal of Agricultual Economics 66(4):499-504.

Gilbert, R. J., D. M. G. Newberry and J. E. Stiglitz. 1978. An Overview of the Economic Theory of Uncertainty and Its Implications for Energy Supply. Micro-economic Associates, Berkeley, California.

Grisley, W., and E. D. Kellogg. 1983. "Farmers' Subjective Probabilities in Northern Thailand: An Elicitation Analysis," American Journal of Agricultural Economics 65(1):74-82.

Hadar, J. 1974. "Stochastic Dominance and Diversification," Journal of Economic Theory 7(3):231-240.

Hamal, K. B., and J. R. Anderson. 1982. "A Note on Decreasing Absolute Risk-Aversion among Farmers in Nepal," Amsterdam Journal of Agricultural Economics 26:220-225.

Hazell, P. B. R. 1971. "A Linear Alternative to Quadratic and Semivariance Programming for Farm Planning under Uncertainty," American Journal of Agricultural Economics 53(1):53-62.

Helmers, G. A., and J. Atwood. 1983. Kinds of Sources of Risks in Livestock Production and Marketing. Paper presented at S-180 Meetings, San Antonio, Texas, March 28-30.

Helmers, G. A., L. J. Held and M. J. Watts. 1982. Estimating the Impact of Safety First Risk Constraints on Risk-Income Frontiers. Selected Paper at the Annual Meeting of the American Agricultural Economics Association, Logan, Utah, August 1-4.

Higgs, R., C. Heidenrich, R. Loberger, R. Cropp and M. Mitchell. 1981. Agricultural Mathematics: Problems in Production, Management, Marketing, Mechanization and Environmental Quality. The Interstate Printers and Publishers, Inc., Danville, Illinois.

Hildreth, C., and S. J. Knowles. 1982. Some Estimates of Farmers' Utility Functions. University of Minnesota Agricultural Experiment Station Technical Bulletin 335.

Kliebenstein, J. B., and F. P. McCamley. 1982. Impacts of Energy Allocation on Income and Risk for Crop Producers. Selected paper, Annual Meeting of the American Agricultural Economics Association, Logan, Utah.

Maddala, G. S. 1977. Econometrics. McGraw-Hill Book Company, New York.

Mapp, H. R., Jr., M. L. Hardin, O. L. Walker and T. Persound. 1979. "Analysis of Risk Management Strategies for Agricultural Producers," American Journal of Agricultural Economics 61(5): 1071-1077.

Mendenhall, W., and J. E. Reinmuth. 1974. Statistics for Management and Economics. Duxbury Press, North Scituate, Massachusetts.

Mendenhall, W., and R. L. Scheaffer. 1973. Mathematical Statistics with Applications. Duxbury Press, North Scituate, Massachusetts.

Mihram, G. A. 1972. Simulation: Statistical Foundations and Methodology. Academic Press, New York.

Naylor, T. H. (editor). 1971. Computer, Simulation Experiments with Models of Economic Systems. John Wiley and Sons, Inc., New York.

Nelson, R. D. 1985. "Forward and Futures Contracts as Preharvest Commodity Marketing Instruments," American Journal of Agricultural Economics 67(1):15-23.

Patrick, G. F. 1981. Producers' Attitudes, Perceptions and Management Responses to Variability. Paper presented at the Southern Regional Research Project S-180, "An Economic Evaluation of Risk Management Strategies for Agricultural Production Firms." Annual Meeting, New Orleans, Louisiana.

Pritsker, A. A. B., and C. D. Pedgen. 1979. Introduction to Simulation and SLAM. Systems Publishing Corporation, West Lafayette, Indiana.

Roumasset, J. A., Jean-Marc Boussard and I. Singh. 1979. Risk, Uncertainty and Agricultural Development. Agricultural Development Council, New York.

Schoemaker, P. J. H. 1982. "The Expected Utility Theory: Its Variants, Purposes, Evidence and Limitations," Journal of Economic Literature 20:529-563.

van Blokland, P. J. 1982. Hedging for Beginners. Staff Paper 214, Department of Food and Resource Economics, University of Florida, Gainesville, Florida.

Vickson, R. G., and M. Altmann. 1977. "On the Relative Effectiveness of Stochastic Dominance Rules: Extension to Decreasingly Risk-Averse Utility Functions," Journal of Financial and Quantitative Analysis 12:73-83.

# BIOGRAPHICAL SKETCH

Kwabena Asomanin Anaman was born on December 28, 1954, at Agona-Nsaba, Ghana, Africa. He attended elementary schools at Agona-Nsaba, then secondary school including the two-year sixth form college at Achimota School, Accra, Ghana.

In October 1974, he entered the University of Ghana, Legon, Ghana, to do a three year Bachelor of Science degree course in agriculture and completed it in September 1977, with first class honors. He was the recipient of the Accra Rotary Club and Shell (Ghana) Limited cash prizes for academic excellence at the University of Ghana for 1976 and 1977, respectively.

He worked two years (from 1977 to 1979) after acquiring the Bachelor of Science at the Center for Development Studies, University of Cape Coast, Cape Coast, Ghana. The first year was the one-year national service for which he received a distinction certificate in August 1978. The second year was in a position of a Junior Research Fellow involved in research and teaching.

He was involved with three farm management surveys involving small and large scale farms in three out of the ten political regions of Ghana. He co-authored a report on the evaluation of village community farms in the Techiman and Nkoranza Districts of the Brong-Ahafo Region in October 1978.

He entered the University of Florida, Gainesville, Florida, in September 1979 to undertake graduate studies in agricultural economics and received the Master of Science degree in 1981. He was admitted as a member of The Honor Society of Agriculture, Gamma Sigma Delta, at the University of Florida in 1982. In 1984, he received the University of Florida Presidential Recognition Award for academic excellence.

He served as the Vice-President of the African Students Union of the University of Florida for the 1979-80 academic year and as an Alachua School Volunteer from 1980 to 1985. He is a member of the Southern Agricultural Economics Association and the American Agricultural Economics Association.

He has written several published and unpublished papers including conference papers on the economics of agricultural production. His professional interests lie in consultancy, research and teaching in the general area of farm management, production economics and international agricultural development. His first book, African Farm Management--Principles and Applications with Examples, is being reviewed for publication by the Ghana Universities Press. He has also developed the draft of a farm management board game which reflects the type of farming pursued by African small scale farmers.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William G. Boggess
Dr. William G. Boggess, Chairman
Associate Professor of Food and
Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Gary D. Lynne
Dr. Gary D. Lynne
Associate Professor of Food and
Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Dr. Clyde F. Kiker
Associate Professor of Food and
Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Max R. Langham
Dr. Max R. Langham
Professor of Food and Resource
Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

JW Jones

Dr. J. W. Jones
Professor of Agricultural Engineering

This dissertation was submitted to the Graduate Faculty of the College of Agriculture and to the Graduate School, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1985

Jack L. Fry

Dean, College of Agriculture

Dean, Graduate School